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ERAWATCH COUNTRY REPORTS 2011: Lithuania

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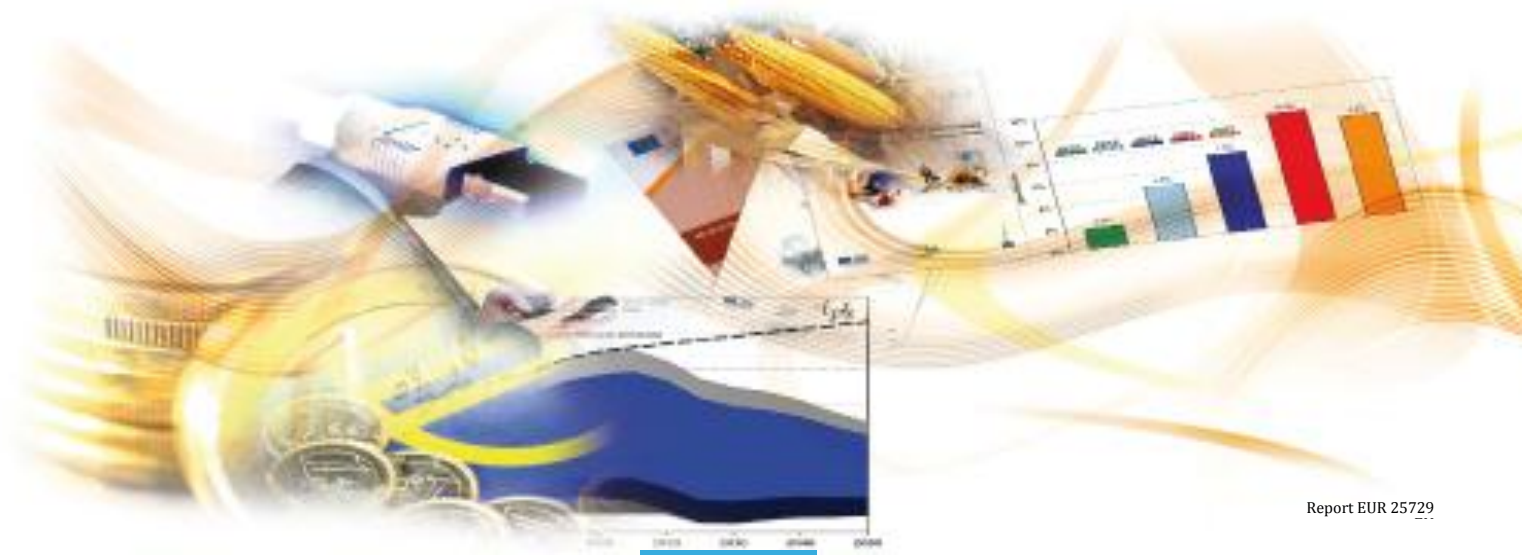

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Executive Summary

In 2011 Lithuania had a population of approximately 3.24m[1], and is thus the seventh smallest country in the EU. The 14 universities form the backbone of the Lithuanian research system. Public higher education institutions (HEIs) carry out most of the R&D in the country (53.2% of the total R&D in 2010) and governmental research institutions (17.6% of all R&D). In 2010, 29% of all R&D carried out in Lithuania was attributed to the *private* sector. Medium and high-tech industry and services are the principal R&D investment sectors. The most important technological sectors for R&D performance in Lithuania in 2010 were computer, electronic and optical products (7.0% of total R&D expenditure), basic pharmaceutical products and the pharmaceutical preparations sector (4.5% of total R&D expenditure), the chemicals and chemical products sector (3.8% of total R&D expenditure) and the manufacture of machinery and equipment n.e.c (3% of the total R&D expenditure) (source: Statistics Lithuania).

The Lithuanian authorities have set a **national R&D target** of 1.9% of the national GDP/R&D intensity in 2020, of which at least half should be contributed by business investments in R&D. The R&D figures of the last three years, however, do not indicate that the targets will be met by 2020. The GERD/GDP figure fell by 0.04 percentage points to 0.79% of total GDP in 2010, which should be attributed to growth in the total real GDP. Business enterprise R&D expenditure (BERD) as a percentage of total GDP increased from 0.20% in 2009 to 0.23% in 2010, while the total intramural Government R&D expenditure (GOVERD) fell from 0.20% in 2009 to 0.14% of total GDP in 2010. In terms of GOVERD Lithuania with €11.6 per inhabitant or 0.14% (€38.5m) of the total GDP was below the EU-27 average of €65.1 per inhabitant or 0.27% of the national GDP on average (€1.2b). The contrast in terms of BERD was much sharper: Lithuania's BERD as a percentage of the total GDP (0.23%, or €63.8m) was significantly below the EU-27 average (1.25% of national GDP, or €5.6b on average). Between 2007 and 2010 there was no significant change in total R&D investments in Lithuania. In addition, the current GERD/GDP figure for Lithuania (0.79% or €218.8m) is less than half the EU-27 average (2% of GDP, or €9.1b on average).

Lithuania suffers from relatively low *research outputs* as compared to the existing inputs. It scores below the EU-27 average in almost all the research output indicators with the exception of the overall level of PCT patents. Most of the *research input* indicators are close to the EU average in countries with similar levels of economic development. An exception here however, is the numbers of new doctoral graduates, where Lithuania scored below countries with a similar profile. The lack of innovators in business due to the unfavourable structure of the economy, *low business R&D expenditure* and low propensity to establish innovative companies, as well as the weak, fragmented and uncompetitive public science base have constituted the **structural gaps** of the national innovation system (NIS) for decades. The public research system is suffering from a *weak capacity to produce knowledge*, due to the insufficient quality of human resources and infrastructures, the unattractiveness of research as unattractive research careers, and the relatively closed science base. While the above-mentioned challenge is extensively addressed by the existing policy mix (see below), the need to tackle the *weak capacity to exploit and commercialise knowledge* and *weak interactions in the innovation system* is increasingly evident.

[1] If not stated otherwise, Eurostat data is used.

The principal **objectives of the current research policy** are laid out in the broad-based Lithuanian Innovation Strategy for 2010-2020 (LIS), approved by the Government in February 2010. Objectives and priorities established by LIS are broadly aligned with central issues of the European policy discourse: the new strategy demonstrates a shift towards a "broad-based" innovation strategy; it extends the definition of innovation, by including social, customer-oriented, non-technological, demand-oriented, and public innovation; and puts much stronger emphasis on policy internationalisation, entrepreneurship and creativity. However, ambitions to expand and re-align the policy mix to make it fit better with the new policy objectives remain constrained by the state budget crisis. Therefore, the policy framework established in the context of the Lithuanian Strategy for the Use of the EU's Structural Assistance 2007-2013 has been kept stable apart from a few reallocations and the introduction of small-scale measures aimed at speeding the knowledge transfer processes between the business and university sectors in Lithuania and abroad. There remains a mismatch between the existing policy mix and some of the new policy objectives. For example, the LIS Action Plan for 2010-2013 does not foresee novel measures that would contribute to fostering the social, customer-oriented or public innovation (LIS objective 3.3), the establishment and growth of young innovative companies, start-ups (especially „gazeles") (objectives 3.2 and 3.4), internationalisation of innovation networks (objective 1.3).

As noted, the **Lithuanian research, technological development and innovation (RTDI) policy mix** (worth €800m for the 2007-2013 period) is mainly funded/co-funded by the European structural funds (SF), while a relatively low part (up to 10%) is funded solely from the state budget. Direct support grants account for most of the support funding; but tax incentives and risk capital funds have also been available to R&D intensive companies since 2008. If EU SF support granted for the development of research infrastructures in thematic fields (science "valleys") and the 12 "national complex programmes" is considered, the split between generic and thematic R&D funding is about 50/50. After heavy higher education funding and governance reforms during 2008-2011, competitive funding of research comprises about 50% of total funding, with the balance being results-based. The above overview of recent trends indicates that the model of funding prevalent in Western Europe is slowly gaining grounds in Lithuania.

The current policy mix is mainly directed at three principal routes: (1) firstly, *to increase knowledge production (R&D) capacities in the public sector* (about 60% of total planned public R&D investments during 2007-2013). The greater share of the funds is oriented towards investments in R&D quality (research careers and public research infrastructure), followed by governance reform, e.g. introduction of student vouchers and optimisation of the research institutes network, among other innovations; (2) secondly, *to stimulate greater R&D investment in R&D performing firms* (about 26% of total planned investments that are spread over a number of small measures from idea testing to direct support to R&D in business and innovation services); (3) thirdly, *to increase knowledge transfer and links between the industry and university sectors* (about 14% of total planned investments for 2007-2013, or €115m, if activities actually funded are taken into account). The group of measures in this route comprises innovation vouchers, investments in innovative clusters development and joint R&D projects.

On the one hand, the predominant support for restructuring the public research system, which has been a bottleneck in the national innovation system for decades, meets the needs of a "catching up country". On the other hand, this structuring of Lithuanian R&D priorities implies the following conclusions about several major **weaknesses of this**

policy approach. *Firstly,* by focusing primarily on funding of the public sector and firms already performing R&D, this policy strategy understates other objectives, such as stimulating young innovative firms and firms that do not yet perform R&D. Furthermore, the current policy mix is also lacking support for technological and experimental development activities in companies, including the development and testing of prototypes. Secondly, there remains a gap between the policy intentions to foster business-academia collaboration and the critical mass and effectiveness of implemented interventions. The "valleys" concept is criticised in the public discussion for focusing too much on "bricks and mortar" rather than on joint R&D projects or professional knowledge transfer services. *Thirdly*, no clear conceptual approach exists in Lithuania to align demand-side and supply-side RTDI measures, which is the principal cause of the absence of market incentives and public procurement for innovation in the strategically important economy sectors such as energy and health care. *Fourthly,* cross-border/international collaboration in research and innovation, as well as knowledge transfer and public-private partnerships remain the least addressed ERA objectives. Given the remaining bottlenecks, the focus of policy makers in the forthcoming three-year period has to be on a re-alignment of the RTDI policy mix for 2014-2020 periods towards these **policy challenges**:

- Ensuring the adequacy of public R&D funding and *focusing the investments* on the priority scientific and technological areas where Lithuania is strong and capable of competing internationally, especially those oriented towards addressing major societal challenges;
- Increasing the *attractiveness of research careers* by further reforming university governance systems, ensuring attractive working conditions, open recruitment and cross-border mobility, as well as easy access to research grants;
- Addressing knowledge transfer failures by further developing *instruments to support technological development and commercialisation* of innovative ideas such as support to professional technological/innovation services, innovation clusters, knowledge transfer platforms; developing innovation culture and skills in universities and public research institutes, as well as the right incentives and training for researchers in the public sector to engage in knowledge transfer and commercialisation activities;
- Constructing a broad-based innovation policy framework – ensuring the *consistency of supply and demand-side policy instruments*, fostering a public sector, demand-oriented, services sector, non-technological innovations;
- Development of framework conditions promoting private investment especially focusing on *young innovative companies and start-ups*;
- "Opening" the R&D programmes and *coordinating R&D programmes trans-nationally* where relevant, in particular with neighbouring countries;
- Addressing governance failures especially *inter-departmental coordination and policy intelligence* (policy monitoring and evaluation systems) as repeatedly noted by experts.

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1 Introduction

In 2011 Lithuania had a population of approximately 3.24m, and was thus the seventh smallest country in the EU. According to statistical estimates, in 2011 Lithuania experienced a significant increase of 5% in real GDP growth, although this was still below the heights of the pre-2008 economic downturn. The GDP per capita increased by roughly 6% to €8,400 per person in 2010, although in terms of GDP per capita in Purchasing Power Parity (PPS) it still comprised only 57% of the EU-27 average (€24,400 per person in 2010).

The intensity of R&D funding in Lithuania measured as the GERD percentage of GDP in 2010 fell by 0.04 percentage points from 0.83% in 2009 to 0.79% of total GDP in 2010. This decrease, however, should be attributed to growth in total real GDP rather than to the lesser intensity of R&D funding. According to Eurostat data, total GERD in Lithuania decreased only slightly from €221.56m in 2009 to €218.84m in 2010. Business enterprise R&D expenditure (BERD) as a percentage of total GDP increased from 0.20% in 2009 to 0.23% in 2010, while the total intramural Government R&D expenditure (GOVERD) fell from 0.2% in 2009 to 0.14% of the total GDP in 2010. In 2010, GOVERD as % of GDP in Lithuania (0.14% or €38.5m in total) was slightly below the EU-27 average (0.27% or €1.2b), while the contrast in terms of BERD was much sharper: Lithuania's BERD as a percentage of total GDP was only 18.7% (€63.8m) of the EU-27 average (1.25% of the total GDP or €5.6b). Moreover, in terms of Euro per inhabitant for GOVERD, Lithuania with €11.6 was sharply below the EU-27 average (€65.1 per inhabitant). The respective figure for BERD was even more pronounced: €19.2 in Lithuania as compared to €301.6 per inhabitant on average in the EU-27. In terms of Euro per inhabitant for GERD, Lithuania (with €65.7 per inhabitant) also differed significantly from the EU-27 average (€490.2) (see Table 1 below).

Table 1: Main R&D indicators

	2010	EU average 2010
GERD as % of GDP	0.79	2
GERD (€ million)	218.8	9.1 (b)*
GERD per capita (€)	65.7	490.2
BERD (€ million)	63.8	151,125.56
BERD as % of GDP	0.23	1.23
BERD per capita (€)	19.2	301.6
GOVERD (€ million)	38.5	1.2(b)*
GOVERD as % of GDP	0.14	0.27%
GOVERD per capita (€)	11.6	65.1

*Billions of Euros

Source of data: Eurostat.

The number of researchers in Lithuania has been growing during the last decade and the total number of researchers in 2010 was 13,849. According to the Innovation Union competitiveness report 2011, Lithuania suffers from relatively low research outputs as compared to the existing inputs. Lithuania scores below the EU average in almost all the indicators of research outputs except for the overall level of PCT patents, while most of the research input indicators are close to the average of those EU countries with similar

levels of economic development. However, there is an exception to this trend when we look at the numbers of new doctoral graduates, where Lithuania scored below countries with a similar profile. In 2008, for instance, there were 3.77 patent applications per million habitants to the EPO from Lithuania, a number, which was lower only in Bulgaria and Romania, and more than 30 times lower than the EU-27 average (115.52 patent applications per million inhabitants). Moreover, Lithuanian international patenting rates per million inhabitants were 36 times lower than the EU-27 average.

Although Lithuania scored above two other Baltic countries (2,000 scientific papers in 2009) in terms of the numbers of scientific publications, in terms of the impact of these publications, Lithuania with a citation index lower than 0.7 in 2009 scored sharply below the World average. Thus, despite being extensive in its scale, the efficiency of the Lithuanian research sector is relatively low and requires major modifications.

In terms of scientific specialisation of R&D, the dominant scientific fields in Lithuania in 2010 (with most public expenditures in the higher education and government sectors) were biomedical sciences (about 29% of total R&D funding in 2010, according to national statistics sources), technological sciences (roughly 24% of total R&D funding in 2010) and physical sciences (with 17% of total R&D funding in 2010).

In terms of economic specialisation, Lithuania remains a country of predominantly traditional industries (food and beverages, textile, wood and furniture), which do not require high competitiveness in terms of R&D. Medium and high-tech industry and services are the principal R&D investment sectors (see Table 2 below).

Table 2 : Business R&D Expenditure in Lithuania according to sectors of the economy in 2010

Sector of economy	R&D expenditures (€ million) in 2010	R&D expenditures (% of the total business R&D expenditures) in 2010
Financial and insurance activities	12.44	19.5%
Telecommunications	6.7	10.5%
Human health and social work activities	6.5	10.1%
Computer programming, consultancy and related activities	6.1	9.6%
Professional, scientific and technical activities	5.1	7.9%
Manufacture of computer, electronic and optical products	4.5	7%
Manufacture of basic pharmaceutical products and pharmaceutical preparations	2.8	4.5%
Manufacture of food products, beverages and tobacco	2.8	4.4%
Manufacture of chemicals and chemical products	2.4	3.8%
Wholesale and retail trade; repair of motor vehicles and motorcycles	2.1	3.3%

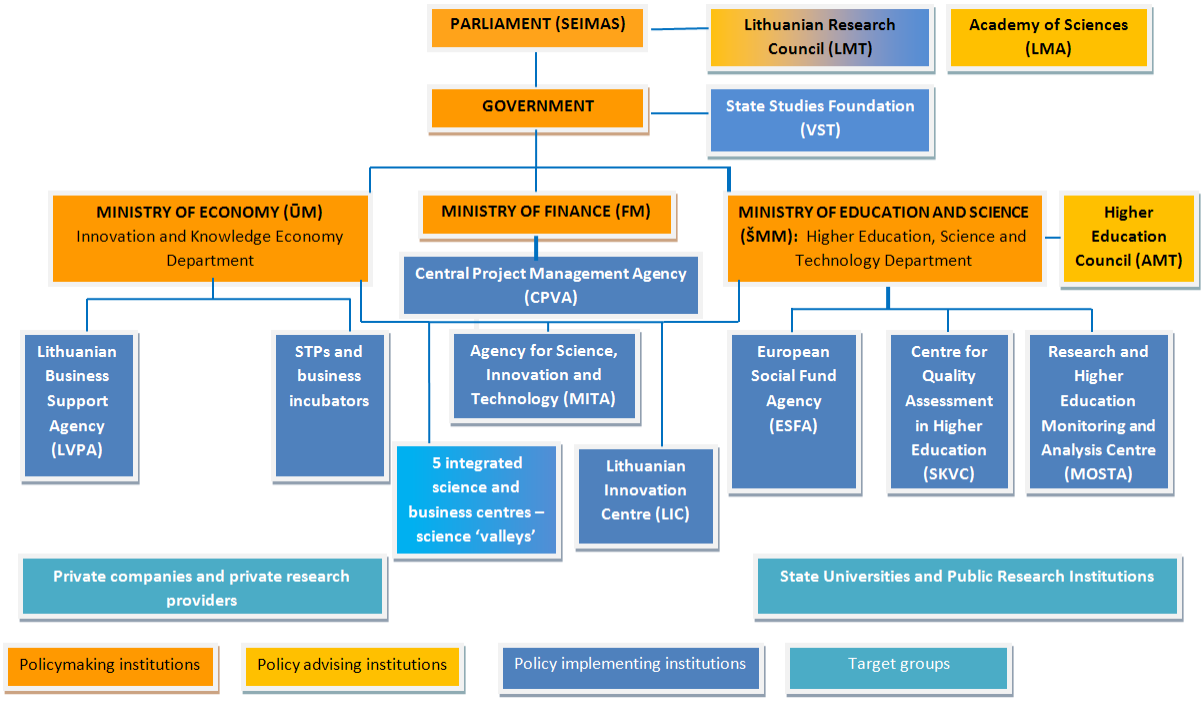
Source of data: Statistics Lithuania

As can be seen from Table 2 above, knowledge-intensive service (KIS) sectors such as financial and insurance activities, telecommunication services, human health and social work activities, and computer programming, consultancy and related activities invested

the biggest share in R&D expenditure in Lithuania in 2010. High-technology and medium-high technology sectors (computer, electronic and optical products, pharmaceuticals, chemicals, and manufacture of machinery and equipment) also accounted for a significant portion of total R&D expenditures. The priority research and development fields defined by the Lithuanian Innovation Strategy for the year 2010-2020 are listed in Chapter 3.1.

The two **principal governing bodies**, shaping RTDI policy in Lithuania, are the Ministry of Economy (MoE), which is responsible for innovation policy, and the Ministry of Education and Science (MoES), responsible for higher education and R&D policy. Following the reorganisation of 2009, several subordinate institutions were established: in order to place higher emphasis on the promotion of innovation; the Department of Innovation and Knowledge Economy was set up, with a separate Division for Business and Science Collaboration, at the MoE. Accordingly, the Ministry of Education and Science (MoES) established a new Division of Technologies and Innovation.

Figure 1: Overview of Lithuania's research and innovation system governance structure



Source: designed by the authors
NB: the figure contains Lithuanian acronyms

In terms of bodies *managing implementation of RTDI policies*, the Lithuanian Research Council (LRC) is the central funding agency for fundamental research, complementing institutional funding for basic research with project-type funding. The State Studies Foundation (SSF, since 2010, previously called the Lithuanian State Science and Studies Foundation) is the main institution dealing with study loans. The development of human resources falls under two agencies: the Lithuanian Centre for Quality Assessment in Higher Education (LCQAHE) and the European Social Fund Agency (ESFA). The first deals with quality assurance and higher education standards. ESFA supports, coordinates and administers EU SF aid and implements measures assigned to the MoES in the development of human resources for science, technology and industry.
Lithuanian innovation and corporate R&D policy is implemented by the agencies and other bodies established by the MoE, the main one of which is the Lithuanian Business Support Agency (LBSA), responsible for the implementation of national and EU SF based business support programmes, including innovation and R&D in the business sector. The Lithuanian Innovation Centre (LIC) provides qualified support for Lithuanian business and research institutions, industry, and SMEs in the field of innovation and technology transfer. Previous assessments of the institutional framework of research and innovation governance focused on two main aspects: fragmentation and lack of clear-cut separation of functions and responsibilities, and lack of inter-institutional coordination (PPMI, 2009). With the aim of reducing fragmentation, the Government established the Agency for Science, Innovation and Technology (MITA) in early 2010 on the basis of the previously existing Agency for International Science and Technology Development Programmes. Functions related to the administration of competitive funding programmes for basic R&D were transferred to the Lithuanian Research Council. MITA has the mandate to become the main governmental institution responsible for the implementation of innovation policy in Lithuania. The administration of the applied R&D and innovation funding programmes will be gradually transferred to MITA. Currently, MITA administers a relatively small share (about €1-3m per year) of the overall RTDI

measures mix. The Board of MITA is comprised of both ministries responsible for innovation and research.
Administration of certain high scale investment programmes related to the development of research infrastructures is the responsibility of the Central Project Management Agency under the Ministry of Finance.
Lithuanian *regions and municipalities* still do not play any role in research governance.
The major part of R&D in Lithuania is performed by the *public* higher education institutions (HEIs) (53.2% of total R&D, or €116.6m in 2010). Another major performer of R&D was Government institutions (17.6% of all R&D, or €38.5m in 2010). Private business carried out 29% of all the R&D in Lithuania in 2010, or €64m).

2 Structural challenges faced by the national system

Lithuania is continues to be among the slowest innovators in the EU – its Summary Innovation Index dropped to 0.227 in 2010 as compared to 0.313 in 2009 and to the EU-27 average of 0.516 in 2010 (Innovation Union Scoreboard, 2010). Compared even to countries of similar scientific and technological profile (such as Latvia), Lithuania scores low in all R&D and innovation indicators except for R&D expenditure in the public sector and employment activities, where the levels in Lithuania are closer to the EU-27 average. The number of researchers in the labour force and numbers of tertiary graduates are among the relative strengths of Lithuania except for new doctoral graduates (European Commission, 2011b).
A weak, fragmented and uncompetitive public science base constitutes the *first structural gap* of the national innovation system (NIS). Lithuania lags substantially behind both the leading and the catching up EU-27 with regard to the ***capacity to produce knowledge***, due to out-dated research infrastructures, low quality of, and aging human resources, and the unattractiveness of research as a career. Low salaries and poor access to academic databases, libraries and world-class equipment remain the principal obstacles to attracting researchers in Lithuania.
Moreover, the Lithuanian science base is still relatively closed with the lowest rates of overall co-publications per million of population. In addition, very few of the scientific publications involving authors based in Lithuania have high impact. According to the Innovation Union Scoreboard (IUS) 2011, Lithuania had a moderate-low rate of international scientific co-publications per million population (the indicator value for Lithuania in 2010 was 71 in relation to the EU-27 indicator of 100). In comparison, the respective indicator values of international scientific co-publications per million population in relation to the EU-27 indicator (100) was 43 for Latvia and 213 for Estonia (IUs, 2011). This indicator for Lithuania does not differ significantly from the 2008 indicator (when the indicator value of international scientific co-publications per million of population in relation to the EU-27 indicator (100) was 75) (IUS, 201). Trans-national collaboration, internationalisation of science, “opening” the national research system, joint design and coordination of policies remain low on the political agenda (ERAWATCH Country Report 2010). This suggests that the country is not actively participating in, and benefiting from, the international scientific knowledge flows favoured by the construction of the European Research Area.
In response to these failures, considerable amounts of Structural Funds are invested in R&D, especially into the creation and development of five clusters (called "Valleys") integrating public research and businesses in identified scientific and technology areas,

and followed by the structural reforms of the higher education system (autonomy and governance of universities, optimisation of the network of public research institutions, increase in the share of competitive funding and of performance-based institutional funding). These reforms of the science base are expected to make the Lithuanian research and innovation system more competitive in the long run.

The second widely acknowledged challenge, which is partly a corollary to the previous one, is the **weak capacity to commercialise and exploit knowledge**, which becomes more evident after heavier investments in research production. Various reports (ERAWATCH Network 2008, 2009, 2010; World Bank, 2009, Lithuanian Innovation Strategy 2010-2020, European Commission, 2011b) note that the Lithuanian innovation system suffers from an imbalance of relatively high inputs into public research and an extremely low scientific output. The EU-27 on average generate 10 times more patents for the same level of funding (Public Policy and Management Institute (further on – PPMI), 2009). Exploitation of R&D results by the business sector is extremely limited with low business R&D expenditure (see third challenge below) and very few patented inventions. If this trend continues, it could have important consequences for the future international economic competitiveness of Lithuania (World Bank, 2009, European Commission, 2011b).

Thirdly, the **low level of business R&D investments and weak innovative capabilities of the businesses** in Lithuania give rise to poor scientific and technological performance. The structural gap rests in the unfavourable structure of the national economy and lack of innovators in business. Knowledge and technology intensive sectors remain small and the extent of their development does not provide any grounds for speaking about convergence - Lithuania is not approaching the EU average in this field (ERAWATCH Country Report 2010). In particular, Lithuania has so far failed to increase the tendency to create and develop new innovative companies. The total number of small and medium-sized enterprises (SMEs) conducting their own R&D on a permanent basis has not grown; the rate of new firms in general is low. Following the economic and financial crises, financing of innovation continues to be a major challenge for SMEs, especially for technology start-ups. Furthermore, the government has paid little attention to the creation and facilitation of *innovative markets*, including those within existing governmental investment programmes that target energy, health care, transport and other important sectors. Several studies (PPMI, 2010a, 2011; InnoPolicy TrendChart Reports 2006-2010) criticised the current research and innovation policy mix as neglecting the possibilities to link innovation demand with technology producing capacities.

Fourthly, there are significant knowledge transfer failures due to the **weak links between education, research and business sectors**. The science "valleys" are expected to strengthen the links between higher-education institutions, research institutions and businesses. However, experts have noted that most of funds are being invested in buildings and laboratories, while the "soft" side of the R&D collaboration (innovation services, IPR rights, joint projects) are being neglected (PPMI, 2010, 2011). There is an urgent need to develop an innovation culture and skills in universities and public research institutes (and Knowledge Transfer Offices in the universities). The right incentives and training for researchers in the public sector to engage in knowledge transfer and commercialisation activities have also to be developed. Additionally, public support should be targeted to the (co-) financing of development phases that follow the R&D phase in firms, e.g. prototypes, feasibility tests, market research and coaching activities (European Commission, 2011b, PPMI, 2011).

3 Assessment of the national innovation strategy

3.1 National research and innovation priorities

The current RTDI strategy in Lithuania is mainly focused on general goals of economic growth and increase of the country's international competitiveness. The principal objectives of the current research policy are laid out in the broad-based Lithuanian Innovation Strategy for 2010-2020 (LIS), approved by the Government in February 2010. Objectives and priorities established by LIS are to a large extent in line with the strategic EU policy documents: the new strategy demonstrates a shift towards a "broad-based" (horizontal) innovation strategy; it extends the definition of innovation, by including social, customer-oriented, non-technological, demand-oriented, and public innovation; and puts much stronger emphasis on policy internationalisation, entrepreneurship and creativity. The four objectives emphasised in the strategy are:

1. To accelerate Lithuania's integration into the global market ("Lithuania without borders");
2. To educate a creative and innovative society;
3. To develop broad-based innovation;
4. To implement a systematic approach to innovation.

The LIS Action Plan 2010-2013, containing a list of specific measures related to research and innovation and developed as a result of efforts by 12 ministries, was approved in October 2010. The Action Plan contains a number of measures:

- implementation of the innovation voucher scheme;
- implementation of joint research programmes (JRP) of Biomedicine and Biotechnology, Material Science, Physical and Chemical Technology, Engineering and Information Technology, Natural Resources and Agriculture;
- implementation of consolidation and internal optimisation in academic and research institutions, enhancing their R&D potential;
- development and implementation of the National Integrated Programmes and National Science Programmes;
- developing student practical training and entrepreneurial skills and providing conditions for students and teachers to travel for internships in foreign companies;
- developing and implementing a subsidy scheme for scientists (mobility visits and research projects);
- providing funding for the implementation of business-initiated R&D projects;
- implementing various types of study programmes and cross-border studies so that by 2020 a minimum 20% of Lithuanian students would have competed part of their studies abroad.

The majority of the above-mentioned measures are implemented through the 2007-2013 EU structural assistance funds (see Chapter 3.3 for more detail on the budgets). In fact, ambitions to expand and re-align the RDI policy mix to make it better fit with the new policy objectives remain constrained by the state budget limitations. Therefore, the policy framework established in the context of the Lithuanian Strategy for the Use of

the EU"s Structural Assistance 2007-2013, and following different intervention logic, has been kept stable apart from a few re-allocations and introduction of small-scale measures. The LIS Action Plan 2011-2013 acted as an inventory of the already existing policy measures rather than introducing a completely new direction for the policy. Consequently, there remains a mismatch between the existing policy mix and some of the new policy objectives. Least addressed policy objectives are: business networking and involvement in international innovation networks (Objective 1.3 of the Lithuanian Innovation Strategy for 2010-2020); establishment and growth of young innovative companies (especially "gazelles") (objectives 3.2 and 3.4); innovation demand and user-oriented innovations (objective 3.3); promotion of effective business-science collaboration mechanisms and joint business-science projects (objective 3.6).
One of the novel measures – "*innovation vouchers*"(each worth €2,900–€5,800, annual budget €0.3m), was introduced by the MoE and the Agency for Innovation, Technology and Science (MITA) in 2010 and funded from the national budget. The principal beneficiaries of the measure are small and medium-sized enterprises (SMEs). Thirty-six innovation vouchers were distributed in 2010, and another 85 – in 2011. Another new measure introduced by the MoE in December 2010 is PRO-LT (€11.6m) aimed at international R&D collaboration between foreign R&D intensive companies (IBM Research laboratories) and Lithuanian universities. Following the agreement, a joint initiative, the Lithuanian Research Centre, was established in 2011. The Lithuanian Research Centre selects collaboration projects and allocates funding of the PRO-LT measure.
Another initiative in the field of RTDI was the extension of the High Technology Development Programme for 2011-2013 (previously existing 2007-2010) that will invest in the development of high technologies in five priority sectors: biotechnology, mechatronics, laser technology, ICT, and nanotechnology and electronics (the budget for 2011 is €0.29m). In March 2011, the Minister of Economy also approved the Industrial Biotechnologies Development Programme for 2011-2013, which is expected to accelerate development of the Lithuanian biotechnology industry (the budget for 2011 is €0.29m). Both programmes are administered by MITA.
Thus, the financial initiatives, consisting mainly of grants, remained as the central instruments in the Lithuanian innovation policy mix during the period 2010-2011. In addition, corporate profit tax incentives for investments in R&D and new technologies have also been available to R&D active companies (since 2008)[2], as have other financial engineering instruments supporting private companies (such as the Controlling fund, or the Business Angels Fund I).
According to the Lithuanian Innovation Strategy for the year 2010-2020, there are 13 *priority business and industry sectors* in Lithuania, which have the potential to create the highest added value, to increase the productivity and development of the country, and which require a critical mass of highly qualified individuals. These business sectors belong to three groups of *traditional industries, advanced and medium-advanced technology industries and the new technology industries* (see Table below).

Table 3: Priority business and industry sectors in Lithuania

[2] *Corporate profit tax incentives for R&D*: expenses incurred by companies carrying out R&D projects can be deducted from taxable income three times; long-term assets used in the R&D activities can be depreciated within two years. *Corporate profit tax incentives for investments into new technologies*: companies carrying out investments into new technologies can reduce their taxable profit by up to 50%. Investment expenses exceeding this sum can be postponed to later, consecutive tax periods (up to five years).

Traditional industries	Advanced and medium-advanced technology industries	New technology industries
Food products and drinks; Wood and furniture; Textiles; Chemicals, chemical products and chemical fibre.	Biotechnologies; Laser technologies; Electricity and optical equipment; Information and communication technologies; Transport and logistics.	Clean technologies; Future energetic; Creative industry; Welfare and wellness areas (pharmacy, medical and wellness services, medical and wellness equipment, technical and gear area, production of ecological agricultural and food products and other).

Source: Lithuanian Innovation Strategy for 2010-2020

Reflecting the key societal challenges Lithuania will face in the future, the Lithuanian Research Council also approved a list of *National Research Programmes* in 2008: future energy; chronic non-infectious diseases; Lithuania's eco-system: climate change and human factor; safe and healthy food; state and the nation: heritage and identity. Each programme will receive a total investment of €5.7m for the three-year period.

In addition to the National Research Programmes, a list of *Joint Research Programmes* (JRPs) was approved by the Government in the following fields: natural resources and agriculture, biomedicine and biotechnology, materials science, physical and chemical technologies and engineering and information technologies. The design of the JRPs is tied closely to the implementation of the programmes of the five integrated centres ("valleys") of science, studies and business to be established and aimed at consolidating the potential of scientific research, studies and knowledge intensive business sectors. The MoES intends to allocate up to €400m for implementation of the "valleys" programmes through the National Integrated Programme and the General National Research and Science and Business Cooperation Programme.

Moreover, 12 *National Complex Research Programmes* (NCPs) were approved in: biotechnology and biopharmaceuticals; lasers, new materials, electronics, nanotechnologies and applied physical sciences; sustainable chemistry; ICT; medical sciences; sustainable environment; mechatronics; civil engineering and transport; cultural and creative industries; marine sector; agriculture, forestry and food industry. Thirty four research projects under the NCPs are funded with a total budget of €34m.

About half of the above-listed research fields (namely, food, future energy, biomedicine and biotechnologies, ICT, laser, electrical and optical technologies) have been repeatedly prioritised since 2002 both in terms of development of industrial sectors and in terms of research. On the one hand, the chance to achieve innovation „breakthrough" would be higher if limited state resources were concentrated in these particular fields benefiting from both the efforts in research and efforts for the industrial development of the sector. On the other hand, this is in line with the structural challenges identified in Chapter 2 to invest in restructuring a larger number of industry sectors, given that the above-mentioned priority fields only form a small part of the national economy.

Evaluators[3] laid out the following conclusions about the impact and effectiveness of current Lithuanian RTDI policies:

[3] The conclusions are summarized based on three small-scale evaluations (with budget less than €50,000) of research and innovation policies in Lithuania conducted during 2010-2011: PPMI (2010a): Study on the innovation policy and innovation governance in Lithuania. Knowledge Economy Forum, Vilnius; PPMI (2010b): Systemic innovation policy evaluation report. Prime Minister's Office in Lithuania, Vilnius; PPMI (2011): Evaluation of the industry and science collaboration policy mix in

- *Firstly*, the current policy measures implemented by both MoE and MoES will most probably strengthen the public R&D base and knowledge production in the public sector since the greater part of public R&D funding (60%) as well as systematic reforms are concentrated in this area.
- *Secondly*, the impact of the current policy mix on the collaboration between the science and business sectors is estimated to be average because of the systemic barriers existing in this area: lack of a proper legal base for the successful commercialisation of scientific projects, the low quality of scientific research, and overly bureaucratic governance of HEIs. It was also argued that the current policy mix lacks a critical mass of "soft" projects to effectively foster business-science links.
- *Thirdly*, the relevance of the new policy objectives is high, as is the relevance of currently implemented policy measures. The weakest links (where the existing policy mix does not sufficiently reflect existing structural challenges) are: technological development (e.g. prototype development, testing) and commercialisation of research products and lack of related, professional, well targeted innovation support services; support for the establishment and growth of new innovative companies; lack of demand-oriented policy measures; the "subsidies culture"; and lack of attention to internationalisation strategies of research.
- *Fourthly*, evaluation of the utilisation of the innovation support infrastructure (science parks and incubators, especially at the five science valleys) shows that the policy goals will be only partially achieved due to four major problems: a) too much focus on infrastructure and not enough on "soft" innovation projects, e.g. R&D collaboration projects; b) insufficient communication of information on the utility and opportunities given by the R&D and innovation infrastructure in the country; c) the absence of the innovation support services; d) low quality of the services rendered by the current R&D infrastructure.
- *Finally*, the evaluation showed that, although extensive, the current institutional base for the implementation of R&D policies is at the same time very fragmented. This weakness prevents the current institutional system from exhausting all the existing competences and advantages of a scale economy. The authors of the evaluation report argued that the RDI governance system lacks strategic intelligence systems, especially where the Ministry of Economy and the business-related RDI policy measures are concerned. There is great need for a policy advising institution and development of strategic intelligence (policy evaluation, monitoring and foresight) systems in the innovation policy field.

3.2 *Trends in R&D funding*

According to the National Reform Programme of Lithuania issued in April 2011, Lithuanian authorities have set a national R&D target for 2020 of: 1.9% of national GDP by 2020, of which at least half should be contributed by private (business) investment in

Lithuania. In addition, the Report by the National Audit Office on science/business interaction was also conducted in support of many of the previous conclusions (2011). Some of the on-going evaluations (e.g. on the monitoring and evaluation of the "science valleys") are not made publicly available.

R&D. The Lithuanian Progress Strategy 2030 foresees that Lithuania should be 15th in the EU-27 according to BERD/GDP figures by 2020, and 10th – by 2030 (Lithuania was 23rd in 2010, according to provisional Eurostat data; the BERD/GDP was lower only in four EU-27 countries: Poland, Romania, Latvia and Cyprus).
The R&D figures of the last three years do not indicate that these targets will be easily met by 2020. According to the statistical data, in 2010 the amount of total intramural R&D expenditure (GERD) as a percentage of GDP in Lithuania suffered a small decline of 0.04 percentage points (from 0.83%, or €221.56m, in 2009 to 0.79%, or €218.84m, in 2010). Thus, it is evident over the last 3 years between 2007 and 2010 there was no significant change in total R&D investment in Lithuania. Moreover, the current GERD/GDP figure for Lithuania is less than half the EU-27 average (which, according to Eurostat estimates, accounted for 2% of total EU GDP in 2010).

Table 4: Basic indicators for R&D investments in Lithuania

	2008	2009	2010	EU average 2010
GDP growth rate (%)	+2.9	-14.7	+1.3	2,0
GERD as % of GDP	0.79	0.83	0.79	2.0
GERD per capita (€)	76.6	66.1	65.7	490.2
GBAORD (€ million)	84.8	69.9	46.9	92,729.05
GBAORD as % of GDP	0.26	0.26	0.17	0.76
BERD (€ million)	61.2	52.6	63.8	146,936,7*
BERD as % of GDP	0.19	0.20	0.23	151,125.56
GERD financed by abroad as % of total GERD	15.5	13.1	20.0	1.23
GERD financed by the Government as % of total GERD	55.6	53.9	47.5	N/A[4]
R&D performed by HEIs (% of GERD)	53.1	52.7	53.2	24.2
R&D performed by PROs (% of GERD)	23.1	23.6	17.6	13.2
R&D performed by Business Enterprise sector (as % of GERD)	23.8	23.8	29.2	61.5

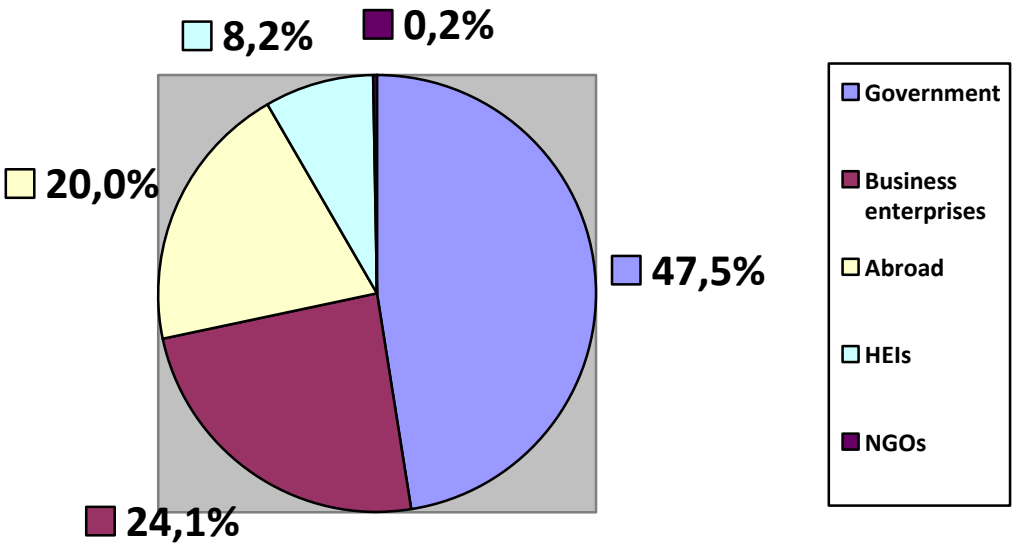
* Total for the EU-27
Source: Eurostat data

Analysis of investment sources in R&D, however, indicates a significant change in the distribution of the investor shares in Lithuanian R&D. In 2010, the amount of total intramural R&D expenditure (GERD) financed by abroad as a percentage of total GERD increased by almost 7 percentage points (from 13.1% in 2009 to 20.0% in 2010). This sharp increase of foreign investments in Lithuanian R&D indicates an intensifying financial support from international organisations and increasingly effective foreign investment promotion policies of the Lithuanian Government.

The share of government investment in R&D declined sharply at the same time from 54% in 2009 to 47.5% of total GERD in 2010. This change is a result of the conservative government cutbacks on the public spending, which took place in 2010 due to growing pressure from the financial crisis. The data demonstrates, however, that, despite this shift, government funds remain the most important source of R&D funding in Lithuania, followed by the business enterprise funds accounting for 24.1% of the total sources (a 3% increase since 2009) (see Figure 2 below).

[4] 8.4 (2009), 9.04 (2005)

Figure 2 : Investments in R&D in Lithuania according to sources of funding



Source: The Lithuanian Department of Statistics, 2011

The negative shift from the government to the role of the private sectors in R&D is also reflected by the targets of R&D performance according to different sectors. While R&D performed by PROs (% of GERD) decreased by 6 percentage points, the target for R&D performed by the Business Enterprise sector (as a percentage of GERD) increased by almost the same value (5.4 percentage points).

Delayed implementation of the EU SF programmes also contributed to shrinking R&D expenditures in 2010. Data of February 2012 on the take-up of SF funds[5] indicate that only about 22% of total funds allocated for the 2nd priority "R&D for economy competitiveness" of the "Economic Growth" Operational Programme have been actually paid out to the projects, although the amount of selected projects is about 70% of total funds allocated for the 2008-2013 period. In late 2010, this figure was about 6 to 8% of the funds secured for RTDI for the period 2007-2013 (2% in case of large infrastructure development projects in the science ,valleys)[6]. Bearing in mind that roughly 90% of all R&D funding comes from the ESF/ERDF, this trend indicates that Lithuania should organise the allocation of SF funding in a more efficient way in order to accelerate the development of its R&D. Thus, although the share of funding from private business and international sources is growing, Lithuania should still modernise its capacities to obtain research funding from international sources and business.

In terms of the distribution of expenditures for R&D among different sectors, there was a small shift from Government sector to R&D in the private business sector between 2009 and 2010. The largest share of *public research performance* is concentrated in the higher education sector, which performed 53.2% of the total R&D (LSD data) in 2010. This share has fluctuated only slightly by 0.5-1 percentage points during the last three years. The government sector performed roughly 17.6% of all R&D (a decrease of 5.4 percentage points since 2009, from €52.3m to €38.5m) in 2010, while the share of R&D

[5] Source: http://www.esparama.lt/2007-2013/en/eu_barometer

[6] Source: PPMI (2010b): Systemic innovation policy evaluation report. Prime Minister's Office in Lithuania, Vilnius

by the Business Enterprise sector increased to 29% of all R&D in the country (an increase of 6 percentage points since 2009, from €52.6m to €63.8m).
The current RTDI policy mix in Lithuania is mainly funded by the European Regional Development Fund (ERDF)/ European Social Fund (ESF). Only a small part (about 5-10%, or about €3m per year) is funded solely from the state budget[7]. The main programmes funded solely from the national budget are: the national research programmes (total annual budget is €1.9m); the innovation vouchers (€0.3m); the Programme of Industrial Biotechnology Development (€0.3m); the Programme for High Technologies Development (€0.3m); the R&D tax incentives (annual budget unknown); and support for industrial intellectual property protection (about €0.2m per year).
Trans-national/trans-regional funding is applied to a relatively limited extent as well. For example the Eurostars programme and five bilateral/multilateral research programmes are implemented (the annual budget of bilateral/multilateral programmes was €0.56m in 2010).
Direct support grants dominate these types of support funding (94% of measures are applying grants schemes)[8]. Tax incentives were introduced for R&D intensive companies were introduced (see Chapter 3.1). Public-private partnerships are relatively unimportant in leveraging additional funding; on the contrary, there remain considerable legal obstacles to private-public partnering in research.
Clearly defined thematic R&D funding comprises about 5-10% of total funding. This ratio would be higher if EU SF support granted for the development of research infrastructures in thematic fields (science "valleys") and the 12 national complex programmes are considered. If these investments are considered as "thematic", the split between generic and thematic R&D funding would be about 50/50.
After heavy higher education funding and governance reforms during 2008-2011, competitive funding of research was about 50% of total funding; the rest of the funding is results-based. The above overview of the recent trends indicates that the model of funding prevalent in Western Europe is slowly gaining grounds in Lithuania. Most of the funding for R&D still comes from the Government and is targeted at the public HEIs. However, there is a slowly growing increase in the amount of funding allocated from private business and international bodies.

3.3 Evolution and analysis of the policy mixes

The planned RTDI policy mix and budgets have not changed much since 2009 as these budgets are planned on a multiannual basis. The structure of the policy mix worth €800m is bound to the EU SF planning documents of the period 2007-2013 and remains heavily constrained by the state budget crisis. The main difference is in the take up of funds. In 2008-2009 most of the currently implemented measures, e.g. Inocluster LT, Inocluster LT+, as well as most of the science „valleys" measures were still at the preparation stage. In 2010-2011 there was increased momentum in the allocation of funds. There were also re-allocations in the budgets that need to be noted. An Economic Recovery Plan was launched in late 2008 by the government,

[7] The official calculations are not available; hence these numbers are approximate and were calculated by the author based on publicly available data.

[8] Subsidised loans, guarantees and venture capital schemes (€274m) are not included here as they are not directly linked to R&D. A number of measures supporting non-R&D innovations, such as E-business LT for development of e-business solutions, New Opportunities-LT for new export markets and business support systems (approximately €30m each), and Process-LT for management innovations (€14.5m) are also excluded. Tax incentives have been applied to foster business investment in R&D since the end of 2008; however no statistics are available for 2009 and 2010.

aimed at restoring market stability and providing greater access to capital for business. In the course of implementation of the so called „crisis" plan, €150m were re-allocated from the science valleys" measures to the venture capital funds.

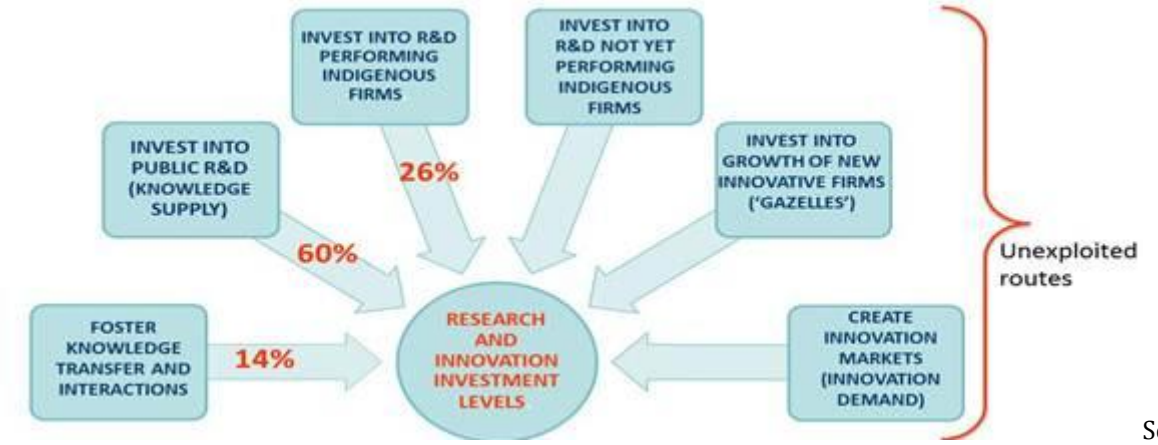
Only a couple of new relatively small pilot measures were launched aimed at speeding the knowledge transfer processes between business and university sectors in Lithuania and abroad: the "innovation vouchers" and the PRO-LT (€11.6m) measures, were both introduced in 2010/2011. Both measures were launched with small budgets (e.g. the innovation vouchers scheme - €0.23m per year). The capacity of the state to launch large scale state funded measures remains extremely limited due to the public budget cutbacks.

The current policy mix is mainly directed at three principal routes:

- **Firstly, to increase knowledge production (R&D) capacities in the public sector** (about **60%** of total planned public R&D investments in 2007-2013, or €480m, see Figure 3). The biggest share of the funds is oriented towards investments in higher education and R&D quality (a majority of measures aimed at public research grants, research mobility and researchers careers via the "Researchers Career Programme" with total budget of €182.5m) and investments in public research infrastructure (about €290m distributed mainly through the targeted "science valleys" programmes). The main target groups of this large share of funding are the universities, public research organisations (PROs) and individual researchers, as well as PhD students. Measures aimed at individual researchers are administered by the Lithuanian Research Council; large projects aimed at strengthening research infrastructures are administered by the Central Project Management Agency under the Ministry of Finance. Alongside the financial measures, the Ministry of Education and Science implements major reforms of the public higher education sector, with the aim of optimising the fragmented system of research and higher education organisations, introduction of market funding elements (student vouchers), increase in competitive and results-based funding and university governance reforms (see ERAWATCH Country Reports 2009, 2010).
- **Secondly, to stimulate greater R&D investment in R&D performing firms** (about **26%** of total planned investments for 2007-2013, or €205m, all administered by the Ministry of Economy and the Lithuanian Business Support Agency). Investments are spread over a number of small measures from idea testing (Idea-LT) to direct support to R&D in business (Intellect-LT and Intellect LT+), innovation services (Inogeb LT-1, Inogeb LT-2). The target groups are primarily business companies with the exception of the Inogeb-LT group of measures where the innovation services providers such as the science parks and incubators can apply for support.
- **Thirdly, to increase knowledge transfer and links between the industry and university sectors** (about **14%** of total planned investments for 2007-2013, or €115m, if the actually funded activities are taken into account). Group of measures in this route comprise innovation vouchers, investments in innovative clusters development (Inocluster LT, Inocluster LT+, and Inogeb LT-3), and joint R&D projects funded by the High technology development programme (2011–2013), the Industrial biotechnology development programme (2011–2013), PRO-LT, and the so called "national integrated programmes". The programmes are administered by the Agency

for Innovation, Technology and Science (MITA) and the Lithuanian Business Support Agency. Knowledge transfer between science and industry is also strengthened by the non-financial measures introduced by the Ministry of Education and Science, e.g. the results-based university funding model (more value to R&D contracts with industry) and the Recommendations on intellectual property management in universities (see ERAWATCH Country Report 2010).

Figure 3: RTDI investment routes, % of total planned public funding 2007-2013



Source: adapted from Public Policy and Management Institute (2011). Evaluation of the Effectiveness of Business-Science Collaboration and Financing Mix

The analysis of the state funds for R&D secured for the period from 2007 to 2013 indicates that these routes comprise the core of Lithuanian R&D policy strategy. On the one hand, the dominance of support to restructure the public research system, which has been a bottleneck in the national innovation system for decades, meets the needs of a "catching up country" (Tsipuri et.al, 2009). On the other hand, this structuring of Lithuanian R&D priorities implies the following conclusions about several major weaknesses of this policy approach.

Firstly, by focusing primarily on the funding of public sector and firms already performing R&D, this policy strategy understated other objectives, such as stimulating firms that do not yet perform R&D and establishment and growth of young innovative firms. The major share of business R&D funds is allocated to private businesses which are already involved in R&D, while there are very few measures aimed at supporting firms, which have not yet started to carry out R&D or that are still in the establishment stage. Although there is a set of SF-funded measures aimed at supporting the creation of new businesses, the funds are not allocated directly to the primary target group (entrepreneurs), but are rather invested in the development of incubator infrastructures.

Secondly, the direct financial support for collaboration of science and business in joint R&D projects, cluster development projects is relatively low, especially if compared to innovation leaders such as Finland. Unfortunately, the initial idea for the development of the "valleys" as integrated business-science centres/clusters was disrupted by existing systemic and legal obstacles that prevent business from entering R&D collaboration with universities (and vice versa). For example, the existing legal system does not allow universities to bring their funds to the joint R&D and/or cluster collaboration projects. Evaluation results[9] demonstrated that business-science collaboration is often more

[9] Public Policy and Management Institute (2011). Evaluation of the Effectiveness of the Business-Science Collaboration and Financing Mix.

formal (in order to meet the eligibility criteria for funding) than real, i.e. leading to joint research. The involvement of business partners in the valleys development process and especially in the valleys governance system has been rather limited. The role of business and even the legal procedures for using the constructed "open access" research infrastructures should be clarified[10]. Some experts argue[11] that if the business involvement issues are unresolved the "valleys" projects will simply become university competence centre development projects rather than R&D collaboration projects. Moreover, the "valleys" concept is criticised in the public discussion for being focused too much on "bricks and mortar" rather than on joint R&D projects or professional knowledge transfer services. The existing measures that directly promote science-industry collaboration, such as innovation vouchers, are too small to achieve any significant results (for instance, the innovation vouchers scheme is €0.3m per year).
Thirdly, one of the major weaknesses of RTDI policies in Lithuania is the lack of a market- and demand-driven policy approach. This is directly responsible for the absence of market incentives and public procurement for innovation in strategically important economy sectors such as energy, waste management and health care. National R&D policy, relying primarily on EU SF funds, and strengthening the public sector along with innovation support understate the importance of the creation of an innovation culture and innovative markets in the country.
Thus, the evident focus on the support of public sector R&D is the most significant trend of the Lithuanian R&D policy mix, which is logical given the current state of public science capacities in Lithuania. On the other hand, other policy routes could be more commonly employed in the short- to medium-term future in order to give a stronger boost to innovative activities in business and to ensure a better innovation supply and demand balance. The effectiveness of the policies aimed at formation of demand and markets for innovation has more importance today when markets are weakened due to the current financial crisis. For example, there was a unique opportunity to form a pool of innovative enterprises while combining energy sector investments, when the Ignalina Nuclear Power Plant was shut down in 2010. The energy sector monopoly, however, prevents the distribution of energy from new sources. A shift of emphasis from the public sector to markets and private businesses (at the same time ensuring adequate funding for public R&D) would be the greatest contribution to the improvement of the Lithuanian RTDI policy mix today.

3.4 Assessment of the policy mix

An assessment of the effectiveness of the existing policy mix (described in Chapters 3.1 and 3.3) to address the structural challenges (described in Chapter 2) is provided in the following table. The table provides an assessment on how appropriate existing policy actions are for addressing specific structural challenges; and what evidence there is from both policy level evaluations and broader reviews/analyses on the impact and outcomes of policies on the structural challenges, as well as on the perceived effectiveness and efficiency of the policy actions.

Table 5 : Assessment of the Lithuanian RDI policy mix

[10] National Audit Office Lithuania (2011): State audit report on the support for science/business interaction; Public Policy and Management Institute (2011). Evaluation of the Effectiveness of the Business-Science Collaboration and Financing Mix.

[11] One of the sources: Inteligentsia Consulting (2009). Report on the Lithuanian Valleys Programme. Available at: http://www.mosta.lt/senas/Tyrimai/Files/Sleniu_valdymo_modelio_ataskaita.pdf

Challenges	Policy measures/actions[12]	Assessment in terms of appropriateness, efficiency and effectiveness
Weak capacity to produce knowledge, due to insufficient quality of human resources and infrastructures, unattractive research careers, and closed public science base	The Researchers Career Programme funds a number of measures that support *research grants and research mobility*. The Economy Development Operational Programme invests €300m in strengthening *research infrastructures* in the defined priority research fields.	Evaluation of these investments has not been carried out. Overall, it may be expected that these streamlined investments will strengthen public research capacities and the attractiveness of research careers in Lithuania, although progress is slow (especially when speaking of governance changes in the public universities). It seems that current focus is on the modernisation of research infrastructures, leaving the "soft" side – salaries system, legal aspects, equal opportunities etc. – aside. Another weakness of the existing policy mix is that it does not aim to "open" the programmes to cross-border collaboration, while the science base remains relatively closed and thus does not benefit from world-class research knowledge and capacities. Also see Challenge 4 below.
Even weaker capacity to exploit and commercialise knowledge	This major bottleneck in the national NIS is tackled directly via three groups of actions: a) Construction of *innovation support infrastructure* (technology transfer centres, technology incubators and science parks; measures Inogeb LT-1, Inogeb LT-2); b) Technology transfer *capacity training* and awareness raising events funded by measures Inogeb LT-1 and „Support of scientists and researchers mobility and students scientific work"; c) *Incentives creation* by introducing Recommendations for intellectual property management at the universities by the MoES in 2008, and strengthening results-oriented higher education and research funding system (more	The current policy mix raises awareness and will possibly strengthen capacity at certain innovation support infrastructure "islands", but it is not sufficient to build a critical mass of professional innovation support services. While the state invests in buildings for the technology incubators and capacity training of services providers, there is a clear lack of professional innovation services (like idea testing, prototype creation and testing, IPR consulting etc.) in the market. Companies do not have access to funds that would allow sharing risky investments in product/services generation after the initial R&D phase. There is a clear need to bridge the gap by: - Defining and standardising innovation support services related to the technological/experimental development and commercialisation and developing a guiding document; - Strongly (legally/financially) supporting development of knowledge transfer offices at/by the universities (the current actions have not lead to visible results); - Introducing specific measures (possibly based on the "voucher"/ "fixed sum" principle) that would provide the companies or individual researchers access to professional innovation support services (idea testing, prototype development and demonstration, future market research etc.) (Public Policy and Management Institute, 2011). As repeatedly noted in the ERAWATCH Reports 2006-2010, and the InnoPolicy TrendChart Mini Report 2011 (see section 3 "Thematic report: Demand-side innovation policies"), **no targeted measures are planned to foster innovative markets** in Lithuania. In our opinion, this is a major weakness of the existing policy mix. During 2010/2011 the Ministry of Economy started discussing the adoption of the innovative and pre-competitive

[12] Changes in the legislation and other initiatives not necessarily related with funding are also included.

Challenges	Policy measures/actions[12]	Assessment in terms of appropriateness, efficiency and effectiveness
	value to contracts with business), and providing *support for protecting industrial knowledge* (but individual researchers cannot apply).	procurement procedures concept. A feasibility study is to be contracted.
Low levels of business innovativeness, based on low business R&D expenditure and low propensity to establish innovative companies, among other weaknesses	Restructuring the economy towards higher value added creating sectors is the overarching objective of main policy documents. Policy actions towards addressing this objective focus on a) providing *access to financing sources* (a number of measures providing grants to business R&D, such as Idea LT, Intellect LT, Intellect LT+, High Technologies Development Programme, Industrial Biotechnology Development Programme, etc., altogether about €162m) and creating *tax incentives* for R&D intensive companies (since 2008).	Results of the interim evaluation of the mentioned business R&D funding measures ((Public Policy and Management Institute, 2011) demonstrated that measures will have a relatively high effect on the input and output additionality (new R&D investments, new products), which was strengthened by the economic crisis (survey results showed rather low crowding out effect). 60% of funds for business grants during 2008-2011 were invested in four priority sectors, of which almost half in ICT. On the other hand, the effectiveness of the current approach is reduced by several factors: a) High administrative costs and overly bureaucratic procedures create a situation where only the strongest R&D performing companies (who can afford expensive consultants) can benefit from the measures. This effect is strengthened by a risk-averse approach when selecting the project proposals (there is a tendency to select projects that can "prove" that they will produce new products/services, therefore less risky projects and possibly less innovative). b) R&D intensive companies in the selected priority fields form a small part of the economy. To achieve a more significant breakthrough in business R&D investments (which are currently €91.2m lower than public R&D investments per year, according to 2010 data), other policy mix routes should be exploited more intensively, especially *investments in newly established companies and spin-offs*, in order to increase the critical mass of high value creating companies in the economy, and innovative markets (as mentioned in the description of Challenge 2). Low propensity to create and develop new innovative companies as well as weak innovation markets remain between the main bottlenecks in the capacity of the economy to restructure towards higher value creating.
Weak interactions in the innovation system (science-business-government links), and lack of systemic approach	The number of measures aimed at creating five *„integrated science-business centres – valleys"*. The largest amount of investments (about €300m) is focused on creating modern research infrastructures (laboratories, open access centres, buildings) in the defined priority research fields. These	The modernisation of research infrastructures is increasing, but it is too early to evaluate the expected effectiveness, and there are no evaluation results publicly available. The study commissioned by the Ministry of Economy on the effectiveness of science-business interactions and available R&D policy mix (Public Policy and Management Institute, 2011) found that there are weaknesses in the chosen approach, as well as systemic barriers in the science-business collaboration that remain unsolved: • Firstly, the balance between investments in infrastructure and "soft" projects (R&D collaboration projects) is uneven, with clear focus on "buildings and

Challenges	Policy measures/actions[12]	Assessment in terms of appropriateness, efficiency and effectiveness
	measures are complemented with relatively small investments in *innovative clusters* creation (Inocluster LT, Inocluster LT+), *innovation vouchers,* and R&D projects in the 12 *„national integrated programmes (NCP)"* (about €51m secured for the NCPs).	laboratories. In addition, legal issues related to the joint usage of "open access" laboratories have not been fully resolved, although steps have been taken to produce the required legal acts. Overall, the involvement of business in the "valleys" has so far been minimal, and remains unclear for the future periods. • Secondly, there are systemic barriers to greater science-business links that diminish the effect of existing measures. One of these barriers is the poor quality of public R&D. One third of companies that applied innovation vouchers were unsatisfied with the results and will not seek further collaboration with university partners. Additionally, there remains a lack of interest on the part of public sector research institutions to collaborate due to various reasons, e.g. bureaucratic governance, legal obstacles to commercialisation of public research results, lack of knowledge on the IPR protection issues, over-occupied researchers, legal obstacles to entering joint projects with business etc. Evidence, provided by the evaluation report, (Public Policy and Management Institute, 2011) suggests that challenges 1 and 4 are inter-related, and that healthy science-business interactions cannot be successfully fostered without firstly strengthening the public science base. On the other hand, certain measures aimed at innovative clusters creation (Inocluster-LT) showed good results in bringing partners along the value creation chain (mainly business companies) together for joint R&D and networking, as well as initiating new study programmes with university partners. These measures have great potential and could be further expanded with more focus on cross-border innovative partnerships. Overall it can be concluded that, despite the newly approved Lithuanian Innovation Strategy calls for "systemic approach towards innovation", at the current stage Lithuania failed, with a few exceptions, to introduce "joint" science-business programmes "and focused on separate measures for public R&D and business R&D. The positive side of the "valleys" creation process are intensified discussions between the ministries of Economy and Education and Science on how to achieve joint programming in the future.

Source: developed by the authors.

The above-mentioned limitations of the policy mix might hamper pushing the national innovation system to the next productivity level. Acknowledging the challenges, the 15th Lithuanian Government put innovation high on the political agenda by adopting a broad-based national innovation strategy in 2010. However, ambitions to expand and re-align the innovation policy mix and to strengthen the institutional capacity to implement and formulate policy remain constrained due to the state budget crisis. Consequently, there remains a considerable mismatch between the new policy objectives and the implemented policy mix.

4 National policy and the European perspective

This Chapter provides an assessment of alignment between the national policy mix and the ERA pillars and objectives (see Table 4). As the analysis indicates, cross-border/international collaboration in research and innovation, as well as knowledge transfer and public-private partnerships remain the least addressed ERA objectives. The suggestions on the possible direction towards which the current policy mix should evolve in the short and medium term, based on the analysis of chapter 2-4, are provided below. The remaining policy challenges are:

1. Ensuring the adequacy and stability of public R&D funding and further **focusing the investments** on the priority scientific and technological areas where Lithuania is strong and capable of competing internationally, especially those oriented towards addressing major societal challenges. It has to be noted that current R&D investment trends (see e.g. the Innovation Union Competitiveness Report 2011) do not allow concluding that the national R&D targets will be met by 2020. Therefore, it is essential that the government commits to even larger R&D funding for the forthcoming period (2014-2020);
2. Increasing **attractiveness of research careers** by further reforming university governance systems, ensuring attractive salaries and working conditions, open recruitment and cross-border mobility, as well as easy access to research grants;
3. Addressing knowledge transfer failures by further developing **instruments to support development and commercialisation** of innovative ideas such as support to professional innovation services, innovation/knowledge clusters, knowledge transfer platforms; developing an innovation culture and skills in universities and public research institutes, as well as the right incentives and training for researchers in the public sector to engage in knowledge transfer and commercialisation activities;
4. Constructing a broad-based innovation policy framework – ensuring the **consistency of supply and demand-side policy instruments**, fostering public sector, demand-oriented, services sector, non-technological innovations;
5. Development of framework conditions promoting private investment especially focusing on **young innovative companies and start-ups**;
6. „Opening“ the R&D programmes and **coordinating R&D programmes trans-nationally** where relevant, in particular with neighbouring countries;
7. Addressing governance failures especially the **inter-departmental coordination and policy intelligence** (policy monitoring and evaluation systems) as repeatedly noted by experts (Whitelegg K., Weber M., Hofer R., Polt W., 2008; ERAWATCH Country Reports 2009-2010; PPMI, 2010, 2011).

Table 6: Assessment of national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA dimension	Main challenges at national level	Recent policy changes

	ERA dimension	Main challenges at national level	Recent policy changes
1	Labour Market for Researchers	Ageing researchers and the relatively low rates of Lithuanian researcher mobility are listed as the principal issues of the Lithuanian researcher market. Finally, the low attractiveness of research as a career, especially the low salaries of researchers, combined with the relatively "closed" science base remain the principal obstacles precluding the attraction of highly qualified researchers to Lithuania (salaries in Lithuania were the seventh lowest in the EU-27 in 2006, 63% below the EU25 average).	Recent trends indicate that the ageing of Lithuanian researchers is being slowly reversed due to the growing number of young PhD Students. The principal instrument for enhancing international research mobility remains the Researchers Career Programme (RCP) that provides funding grants for international researchers and support for researchers who have returned from abroad. The Lithuanian Higher Education Reform of 2009-2011 is assumed to be the major precondition for the increase in researcher salaries. Following the Reform, Lithuanian HEIs will have more autonomy in setting the salaries of its research and academic staff.
2	Cross-border cooperation	Science and research base is rather closed and does not benefit from knowledge available at international world-class research groups.	There are no major policy changes in this field, except several individual measures including „Support to Research Activities of Scientists and Other Researchers (Global Grant)„ started in 2009 and aiming to attract world class researchers to Lithuania, and separate measures aimed at fostering cross-border cooperation with international industry firms in the field of R&D (see Section 2 in the Annex).
3	World class research infrastructures	The current quality of research infrastructures is relatively poor (low researcher salaries and poor access to academic databases, libraries and world class equipment). Moreover, Lithuanian research infrastructures have very few ties with international partners and are not integrated into the European research infrastructures.	Development of "National Integrated Programmes" according to which large investments of SF 2007-2013 and the investments in the five science valleys were planned. One of the major innovations in the Lithuanian research infrastructures development strategy was the publication of the Lithuanian roadmap on research infrastructures ("Lithuanian Research Infrastructure Development Guidelines 2010"), elucidating the strategic needs of Lithuanian science and industry for further investment in the RI of the country. However, the state has not secured any budgets for collaboration with transnational RIs.

	ERA dimension	Main challenges at national level	Recent policy changes
4	Research institutions	Too many students and poor teaching, which does not always include modern curricula, teaching methods and equipment, are identified as the major problems facing Lithuania today. There is also a problem with study programmes and the detachment of university governance from societal and market needs. In addition, public research funding principles that are not based on research results were also identified as weaknesses of Lithuanian research institutions.	Analysis of the 2010 and 2011 figures indicates a decreasing trend in student numbers in Lithuanian HEIs since 2009. The changes in the governance and funding system of the HEIs in Lithuania, introduced by the Reform of 2009, are assumed to have brought the universities and other research institutions closer to the needs of society and the market. New Methodology for allocating "block" funding for public research, introduced by MoES, according to which the allocated funds depends not only on the number of researchers employed, but to a large extent on the results achieved, increased the share of results-based research institutions funding. The Methodology introduced a set of results indicators into the formula, e.g. the amount of applied research activities, collaboration with business, international projects, and other indicators.
5	Public-private partnerships	An underdeveloped intellectual property legal base is one of the most important obstacles precluding a successful partnership and productive interactions between the business sector and research institutions in Lithuania. Researchers, who develop their products in public research institutions, cannot simply transfer this knowledge as their property, because of the risk of being accused of wasting public resources. The Law on Research and Higher Education has guaranteed researchers the right to their research products, however, the ambiguity about research conducted in public research institutions remains. Knowledge Transfer Offices (KTOs) are absent or dysfunctional because of the lack of interest or necessary competences in public research organisations.	Several initiatives were initiated during 2008-2011 aimed at fostering business-research cooperation and scientific knowledge transfer: financial support for the protection of intellectual property rights; measure „Employment of Researchers in Business; integrated science valleys initiative; development of innovation support infrastructure (science parks, incubators). MoES Recommendations for Lithuanian Science and Higher Education Institutions on the Rights Emerging from the Results of Intellectual Activity has also facilitated the protection of intellectual property rights in HEIs. Finally, Innovation Vouchers introduced by the MoE helped to promote cooperation between SMEs and the research community in Lithuania. These initiatives however have not yet demonstrated a sufficient level of effectiveness in stimulating public-private partnerships in exploitation of research results (see sections 2 and 4 in the Table 3 in Chapter 3.4).

	ERA dimension	Main challenges at national level	Recent policy changes
6	Knowledge circulation across Europe	Because of the relatively closed Lithuanian Research infrastructures, the circulation level of Lithuanian research results is low.	There are several measures aimed at developing and disseminating a single Lithuanian research information system: Improvement of the Qualifications and Competencies of Scientists and Researchers (scientific databases, e-documents) with the objective to improve the quality of the work of researchers by creating access to international scientific information data bases; The Creation of National Open Source Scientific Communication Centre aims to develop a single infrastructure for dissemination of research outputs in Lithuania.
7	International Cooperation	Lithuania has not developed any coherent strategy of international cooperation in the field of R&D. Although it has signed several international cooperation agreements in the field of R&D, very few of them have brought substantial R&D results, developed into active research cooperation or attracted significant amounts of funding. The level of cooperation with third countries remains particularly low.	Lithuania currently participates in four bilateral and trilateral international research programmes (see Chapter 7 in the Annex). Other initiatives of international cooperation in R&D include the agreement on cooperation between Lithuanian HEIs and IBM, following implementation of the PRO-LT. Promotion of Advanced International Scientific Research in Lithuania measure, launched in 2010 and supporting joint R&D projects with foreign industry firms, is another example of the promotion of cooperation between Lithuanian research institutions and foreign businesses. Moreover, the Lithuanian Innovation Strategy 2010-2020 mentions integration in transnational networks among its objectives.

Source: developed by the authors.

Annex: Alignment of national policies with ERA pillars / objectives

1. *Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers*

1.1 Supply of human resources for research

As in previous years, the number of R&D personnel in Lithuania is approaching the EU-27 average. Albeit slowly, the number of researchers in Lithuania has been increasing since 1995. According to the Innovation Union Competitiveness Report 2011, in terms of the number of researchers (FTE) per thousand of the labour force, Lithuania with a figure of 5.2 researchers in 2009 was slightly below the EU-27 average of 6.3 researchers. As in previous years, the majority of researchers worked in HEIs (10,489 or 75.7% of all researchers in Lithuania), followed by the researchers working in the private sector (1,771 or 12.8% of all researchers, a 2% increase since 2009) and researchers working in the government sector, accounting for 1,589 researchers (11.5% of all researchers). The most noticeable difference since the last decade, indicated by these data, is the change in the numbers of researchers in different sectors. The share of researchers working in HEIs stopped growing for the first time in this decade and decreased by roughly 1%, while the number of researchers in the private sector has been increasing since 2009. The number of researchers working in the government sector has also decreased by 7% from 1,709 researchers in 2009 to 1,589 in 2010. The decrease can be explained by the previous governments' cuts on public spending on the one hand, and by increasing investments in R&D from the private sector and from foreign investors on the other hand.
Ageing of researchers is identified as one of the principal problems of the current European R&D sector. The number of researchers over 65 years old in Lithuania's R&D sector has increased significantly over the last few years. Analysis of the 2010 data, however, shows that the share of researchers over 65 decreased (by one percent) for the first time in the last decade. At the same time the number of researchers in the 35–44 age group showed a slight increase of roughly one percent. This trend can most probably be explained by the steady increase in the number of PhD students in Lithuania. According to Statistics Lithuania, the total number of PhD students increased by 7.3% (by almost 200 students) in just three years between 2007 and 2010. At the beginning of the 2007-2008 academic year there were 2,520 doctoral students. In 2008-2009 there were 2,595 students; in 2009-2010 there were 2,550 students (a slight decrease of 45 students from the previous year); in 2010-2011 – 2,718 students studying for a PhD degree. Official data on the inward and outward mobility of researchers is unavailable. Multiple studies[13] indicate that the outward mobility of Lithuanian researchers outweigh the inward mobility due to various factors. The overall rates of mobility for Lithuania, however still remain low in comparison to the EU-27 average. According to a study conducted in 2009, for instance, among all researchers in the higher education sector in the EU, the researchers from Greece (73%) and Portugal (70%) have the highest shares of international mobility, while those from Lithuania (44%), Estonia (43 %), Finland (33%) and Slovakia (40%) have the lowest shares[14]. This share of international mobility among Lithuanian researchers was significantly below the EU average (56%).
As in almost all the other EU-27 countries, the internationally mobile researchers were predominantly post-doctoral researchers and experienced scientists, while PhD/doctoral researchers composed the smallest share of all the Lithuanian internationally mobile researchers. Among the internationally mobile Lithuanian researchers in the HE sector, only 18% were doctoral/PhD researchers, 20% post-doctoral researchers, and the rest belonged to other categories of researchers. In terms of field of research, mobility was more intensive among researchers specialising in technologies and natural sciences than among humanities and social sciences researchers.
In addition, researcher's mobility is still largely dominated by short international visits (up to 60% of the researchers go abroad for no more than three months). Only a small percentage of researchers (about 10%)

[13] For example, Leonavičius V. et al. (2010): Qualitative Study on the Mobility of Researchers and Scientists. Centre for Quality Assessment in Higher Education, Vilnius

[14] Study on mobility patterns and career paths of EU researchers, TECHNICAL REPORT 2 – Part I: Mobility Survey of the Higher Education Sector, Brussels, April 2010

stay in foreign research or scientific institutions for a period of longer than a year. Only about 8% of Lithuanian researchers are actively engaged in international networks of research, moreover only 3% of them belong to European Research Centres of Excellence (Leonavičius V. et.al., 2010).

The Researchers Career Programme (RCP) remains the principal instrument for enhancing international research mobility. "RCP foresees funding for these measures: grants for international level researchers (including non-nationals); support for re-integration of researchers working abroad; post-doctoral fellowships; promotion of scientific work of PhDs (support for research, funding scientific internships, PhD scholarships).

1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed

The low quality of national Research Infrastructures (low salaries and poor access to academic databases and libraries, world class equipment) remains one of the principal obstacles to the attractiveness of a research career in Lithuania. According to the EC report "Remuneration of Researchers in the Public and Private sectors" (2007) the level of remuneration for researchers in Lithuania was the seventh lowest in the EU-27 in 2006 - 63% below the EU25 average. In addition, there was a significant gap between remuneration levels in the public and the private business sector, as remuneration of researchers working in the higher education sector was 43% lower than that of those working in the business sector. The principal factor behind the low salary levels of researchers in Lithuania was the old higher education (HE) funding system, which included legal obstacles for a university to determine the salaries of its staff. Recent reforms in the HE sector, which increased the levels of autonomy of universities and the capacity of research institutes to determine the salaries, along with more competitive education and research institutions funding might have a positive effect on the levels of remuneration to research and academic staff in Lithuania. There are no recent studies on progress in restructuring research careers (including salaries level).

The fact that 14 Lithuanian universities had signed the Charter for Researchers by 2011 shows that the Charter is recognised as an important international agreement regulating research activity in the country. The number of signatories to the Charter for Researchers in Lithuania is in a sharp contrast to its equivalent in neighbouring Latvia, where only one university has signed the document.[15] The Lithuanian Research Council's resolution On the European Charter for Researchers and the Code of Conduct for Employment of Researchers of 2006 further declared that monitoring of how successfully the Charter is being implemented in Lithuania, is one of its principal policy aims.

The EURAXESS Lithuania web site is the major information source for foreign researchers looking for vacancies in Lithuania. The information offered by the website covers many issues including social security, taxation, finance and pensions, as well as information on the funding programmes and fellowships available. A major improvement of the website since 2010 is that it has started to publish a list of new vacancies available for foreign researchers wishing to come to Lithuania. The legal conditions for foreign researchers wanting to come to Lithuania are also improved by the existence of a clear system for validating foreign academic qualifications: the Centre for Quality Assessment in Higher Education (CQAHE) is responsible for evaluation and accreditation of all foreign academic degrees.

Overall assessment of the research system in Lithuania indicates that it is relatively closed in terms of opportunities offered to researchers from abroad. Some research funding provided by the Lithuanian Research Council of Lithuania is open to citizens of all countries. This aims to attract talent to Lithuania and particularly to promote return migration of Lithuanian researchers working abroad. For example, Support to Research Activities of Scientists and Other Researchers (Global Grant), started in 2009, aims to attract foreign researchers of international excellence and world-class to Lithuania. According to the rules of the Global Grant, any foreign researcher carrying out work in a Lithuanian institution can apply for funding on an equal basis with leading national researchers; this funding cannot, however, be transferred to the applicants home country or another research institution. In practice it is difficult for a foreign national to apply for this grant (for example, the application forms have to be submitted in Lithuanian). Foreign nationals (including those from third countries) can apply for post-doctoral grants, and there are no restrictions to involving foreign researchers as partners in the research grant application. Several research studies have concluded

[15] Available at: http://ec.europa.eu/euraxess/index.cfm/rights/charterAndCode

that there is a need for open and transparent recruitment procedures that do not favour Lithuanian researchers, with positions being filled on the basis of qualifications. Procedures are established for recognition of qualifications. For example, if a person obtained a PhD degree abroad and wants it to be recognised in Lithuania, he/she must undergo the nostrification process at the Lithuanian Research Council. The procedure of nostrification is as old as 1992 and described by Governmental Resolution No. 549 *Regarding Nostrification of Research Degrees and Academic Titles and Registration of Diploma Certificates* adopted on the 15th of July 1992. Foreign higher education qualifications (e.g. bachelor or master degrees) and qualifications giving access to higher education are assessed by the Centre for Quality Assessment in Higher Education. The situation is changing slowly as more and more foreign national are recruited by Lithuanian universities (especially the private ones). However, cultural change is required in order to have a truly open and transparent recruitment procedure. Currently, recruitment, especially for the higher academic or management positions, are based more on personal connections and coalition building that on academic excellence or other qualifications.

1.3 Improve young people's scientific education and increase interest in research careers

Enhancement of the training, skills and experience of researchers is subject to funding by the Researchers Career Programme (RCP). Measures of RCP include: state support for employment of researchers in business companies; funding training and qualification enhancement of researchers according to the specific needs of the research field or general competences and skills.
Several SF 2007-2013 funded measures are designed to increase creativity and innovation culture, as well as to build mutual trust between science and society: The creation of the National Open Source Scientific Communication Centre; Improvement of knowledge about science and technologies among pupils and youth and support to equal rights in science; as well as Creation of infrastructure aimed at the improvement and dissemination of knowledge about R&D, technologies and innovations. Specifically, the objective of the measure Improvement of knowledge about science and technologies among pupils and youth and support to equal rights in science is to create and implement a young research talents mapping system and to implement the concept of equal rights in science. The specific activities supported are: development of easily accessible information systems; teacher – young researcher mentoring; support for talented pupils interested in science; and supporting equal rights in science.
In Lithuania, the education curricula rarely take into account aspects such as creativity, critical thinking, problem solving, teamwork, and communication skills. The government approved the "National Youth Entrepreneurship Training and Development Programme 2008-2012"in 2008. The Programme sets measures for integration of entrepreneurship training in the curricula of high schools (but not universities), other measures linked to monitoring and analysis of the youth entrepreneurship situation in Lithuania. The National Studies Programme identifies a group of activities - Development of Students Practical Skills and Entrepreneurship, which will include the following supported activities (€11m): development of models of undergraduate and student practice placement in enterprises and non-profit organisations; development of imitative enterprises (centres) and/or implementation of their activities and informal development of student entrepreneurship.

1.4 Promote equal treatment for women and men in research

According to the EC report Remuneration of Researchers in the Public and Private sectors (2007), in terms of the difference in the annual average salary between men and women in the research sector Lithuania is close to the EU-27 average (25.4%) and the gap increases with experience (the difference is above 30% after 15 years of career). Moreover, there is evidence that women are still underrepresented in much better paid leadership positions in the institutions of higher education.
At the moment, there is no systemic approach or legal regulations to promote gender equality on academic and research committees, boards and governing bodies in Lithuania. There are no legal restrictions for female academic and administrative careers in Lithuania. Females constitute about 60% of all students, and there is a slight increase in the numbers of female PhDs. However female scientists are much less active in HE management and hold far fewer academic or administrative positions (except in the fields that have historically not been that appealing to male scientists/administrators). A slight increase in the participation of women in the administration of HEIs is related to the decrease of the general attractiveness of academic careers in society (i.e. it is less attractive to men). Studies show that the problem lies with the attitude of

society, stereotypes and social problems (such as combining an academic or administrative career with family life).

However, there have been several important initiatives aimed at promoting gender equality in the Lithuanian research system. Firstly, gender equality in science and research in Lithuania was formally endorsed by the Lithuanian national Strategy ensuring equal opportunities for male and female in sciences, approved by the Lithuanian Minister of Science and Education in 2008. The second major initiative in this area was the national project "Promotion of gender equality in sciences" (LYMOS), initiated by the regional Baltic States association BASNET Forumas for implementation of the Lithuanian national Strategy ensuring equal opportunities for men and women in the sciences accepted by the Ministry of Education and Science and worked out on the basis of FP6 BASNET project results. The project aims to work out structural bases for implementation of a gender mainstreaming policy in the Lithuanian science system. The project is financed from the European Structural Funds and coordinated by the Lithuanian Academy of Sciences. In addition, there were several studies in this area, funded by the SF 2004-2006 and 2007-2013.

2. *Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding*

Although Lithuanian research funding programmes are gradually opening up to foreign researchers, there is no evidence of any recent national strategic policy documents, which would declare a need to open national research programmes. There are separate joint programming and/or transnational collaboration initiatives that are described below.

Global competition for world-class researchers and the growing need for the return Lithuanian born researchers, who left the country recently for better opportunities abroad, raise the necessity to search for new decisions. One of the most important among them was Support to Research Activities of Scientists and Other Researchers (Global Grant) started in 2009, the principal aim of which is the attraction of foreign researchers of international excellence and world-class to Lithuania. According to the rules of the Grant, any foreign researcher carrying work in a Lithuanian institution can apply for funding on an equal basis with the leading national researchers; the funding, however, cannot be transferred to the applicant's home country.

One of the national policy actions, supporting joint programming and jointly funded activities, directs to the EU Strategy for the Baltic Sea Region adopted by the European Commission in 2009. The strategy aims at financing institutions and non-governmental bodies to promote a more balanced development of the Baltic Region. Funding of R&D is an integral part of the Strategy, since its four principal focus areas of development include environment, economy, accessibility and security.

Project Stardust, co-financed by the European Union's Baltic Sea Region Programme, is another transnational innovation project, aimed at promoting joint development in the Baltic Sea region. The five areas of development are clean technology & future energy, wellbeing & health, future transport, and digital business & services. The strategy of the Stardust activity is concentrated at fostering transnational linkages between specialised research and innovation nodes in order to establish innovation alliances aimed at solving the challenges common to all the 10 Baltic Sea region countries.

Finally, Lithuania takes part in Joint Programming Initiative on Cultural Heritage and Global Change (JHEP), a joint programming initiative, launched in 2011, aimed at protecting the cultural heritage of European countries as well as promoting new forms of public engagement with this heritage, strengthening Europe's leadership in developing science-based conservation, improving competitiveness and enhancing job creation in the broadly defined heritage sector.

3. *Develop world-class research infrastructures (including e-infrastructures) and ensure access to them*

National Roadmaps for Research Infrastructures remains one of the core strategic documents identifying the needs, budgets and priorities of the EU countries future national Research Infrastructures, as well as declaring the need to guarantee and maintain access to research facilities.

In order to develop new RIs corresponding to the latest needs of research in Europe, the European Strategic Forum for Research Infrastructures (ESFRI) was established in April 2002. The principal aim of ESFRI is to co-ordinate European national policies on RIs development and to be a framework for international negotiations on concrete initiatives.

3.1 National Research Infrastructures roadmap

The most important National RI's development strategy of Lithuania developed during the last few years is the "National Integrated Programmes" according to which large investments of SF 2007-2013 were planned in the new and existing RIs in Lithuania.

Under this programme €450m will be invested in creating and upgrading the existing research centres over the period 2010-2015, of which €300m will be used specifically for strengthening the leading RIs. The principal result of these investments is the development of five science-industry clusters, called integrated science, studies and business centres – valleys. A group of foreign experts have concluded while preparing the National RIs Roadmap[16] that massive investments in these programmes first of all mean an upgrading of general RI of Lithuania rather than concentration of funds in any particular area of research. This, in its turn, indicates the relatively low technological level of the country's large RIs. Experts noted that implementation of the "valleys" programme and its success will allow identification of the most prospective research fields, and will therefore will indicate the direction of further investment in RIs.

As in the previous years the thematic groups and RIs, which were successful in joining and participating in international RIs, were predominantly concentrated in natural and technical science areas, such as biotechnology, laser technologies, material science and physics. Examples include the Department of Quantum Electronics of Vilnius University, which hosts the VU Laser Centre (VULRC), a pan-European infrastructure in high power laser technologies, a member of the LASERLAB-EUROPE consortium of European laser infrastructures since 2004.

The overview of the current situation, however, indicates that Lithuanian RIs were no more active in engaging in international RIs projects than in the previous years. VULRC is a partner in ELI (Extreme Light Infrastructure), and the Institute of Lithuanian Language and Centre of Computational linguistics of Vytautas Magnus University is a member of CLARIN (Common Language Resources and Technology Infrastructure) initiative.

According to the Lithuanian representative in ESFRI, there is no systematic approach or a clear strategy for the development and initiation of new RI projects in Lithuania. The development of RIs is sporadic and based on ad-hoc principles. Moreover, formal participation of Lithuanian representatives in ESFRI was less intensive than in 2010 due to budget cuts. According to Lithuanian RI Development Guidelines 2010, it is clear that in the future Lithuanian researchers will need RIs, which cannot, however, be funded by the national government because of the large investments required. Despite this fact, Lithuanian authorities have still not considered the question of Lithuanian RIs participation in larger transnational RIs, which would help to solve this problem. At the moment, neither possible ways of solving the issue, nor the potential transnational RIs that Lithuanian RIs could cooperate with were identified.

3.2. National Research Infrastructures roadmap an upgrade of 2010-2011

One of the major novelties in the Lithuanian RIs development strategy was the publication of the Lithuanian roadmap on research infrastructures ("Lithuanian Research Infrastructure Development Guideline 2010"), elucidating the strategic needs of Lithuanian science and industry for further investment in the RI of the country. According to the roadmap, the participation and the cooperation of Lithuanian RIs in transnational RIs projects is a necessary condition for Lithuanian researchers to conduct world-class scientific research. In addition according to the Guidelines' recommendations, Lithuania could participate in transnational RIs by contributing financially, and in return would have the right to use the resources of these infrastructures and participate in its governing bodies. Alternatively, Lithuanian institutions could join transnational RIs with its particular elements being based in Lithuania and at the same time accessible to all the rest of the members of the RI.

The workgroup, which was responsible for drawing the Guidelines, along with the scientific community and a group of external experts from abroad has evaluated and sorted a list of potential RI projects, which would make the most significant contribution to the country's scientific, economic and social development in the next 10-15 years. In addition, the workgroup has also identified a list of potential large transnational RIs, becoming a member of which could have additional benefits for the Lithuanian RIs.

In terms of RIs openness to foreign access, the only Lithuanian RI, which is currently fully and systemically accessible to foreign researchers, is the RI of Vilnius University (VU) Laser Centre. Between 2004 and 2007,

[16] Lithuanian RI Development Guidelines (2010)

at least 32 foreign researchers conducting 16 international research projects have used the RI of VU Laser Centre. From it can be concluded that Lithuanian RIs, which developed the closest participation in transnational RIs, were at the same time the most open to foreign access.

4. *Strengthen research institutions, including notably universities*

4.1 Academic autonomy

The principal reform made in the area of academic autonomy in Lithuania recently is most closely related to The Law on Research and Higher Education of April 2009, which changed the Higher Education and research governance system in Lithuania in three aspects: the *legal status* of universities and colleges; their *autonomy* and management; and *governance*.

In terms of the *legal status* of universities, the shift resulted from the redefinition of HEIs as Scientific research institutions rather than state budget appropriation managers. As a consequence of this change in legal status, universities were formally granted full autonomy from the state. Full *de facto* implementation of autonomy however will not be realised until HEIs retain full rights to dispose of their real estate and earnings.

The new Law has also reformulated the system of HEIs *autonomy* by expanding its scope. The right to make decisions about employment, dismissal of researchers, their career, remuneration, requirements for higher education programmes and other issues now belong to the Boards of HEIs, not to the state institutions.

The governance of HEIs was reformed by delivering decision-making rights on all operational management issues (changing the status of higher education institutions, their structural reorganisation as well as decisions on the management of their funds, asset) to the HEI Boards; the Boards will also elect the institution's Rector. The Senate will only retain decision-making rights on academic issues. Half of the Board will be composed of persons who are not members of the staff of the HEI and who are appointed by the Minister of Education and Research upon nomination by the Council of Higher Education. The minister will also appoint one of the members in consultation with the Senate. The principal impact of this reform is assumed to be a system of HEI governance, which will be more open to various members of society.

Thus, the autonomy of Lithuanian HEIs has expanded significantly in terms of capacity to design research agendas and recruitment of academic staff. The gaining of complete autonomy in terms of managing HEIs budgets, however, is still to come.

4.2 National HE landscape

The number of students enrolled in the HEIs grew steadily until 2009. In the 18 years between 1990 and 2008/09 this number almost tripled. Since 2009, however, this trend has started to change.

In the 2009/2010 academic year, there were about 144,300 students enrolled at 23 public and private Lithuanian universities (5% less than the year before). The number further decreased in the 2010/11 academic year when there were 133,564 students in universities (a decrease of 7.5% over the 2009/2010 academic year). The trend of the decreasing number of students enrolling in the universities is even more obvious when considering annual numbers of new students accepted in the universities. This number, which was growing steadily up until the 2008/2009 academic year, decreased by 18% in the 2009/2010 academic year from 49,545 to 40,659 new students accepted to Lithuanian universities, and further declined by another 18% in the 2010/2011 academic year to 33,391 new students. The number of students accepted at Lithuanian universities in 2011 remained roughly the same with 33,432 new students accepted. A similar trend of a decrease in both absolute numbers of students enrolled and the number of new students accepted since 2009 is also seen among college students in Lithuania, although the extent of the decrease in the numbers of students in Lithuanian colleges is less pronounced than among the universities.

The changing of the status of HEIs from state budget institutions to public institutions meant that they lost fixed and formula-based funding and were in competition with other HEIs for resources. An immediate consequence of this reform was extension of thee right of HEIs to set tuition fees for their programmes. The new funding system based on student "vouchers" is the formal institutionalisation of this shift in the concept and mission of the HEIs in Lithuania. According to the principles of this new system, student' decisions to choose particular HEIs and programme determine the amount of funding the HEI receives from the Government.

Although certain regulations were implemented (size of vouchers is calculated according to the regulative prices of higher education; limitation of the total number of vouchers; quotas according to the area of higher education) the reform indicated a change to a more market-oriented concept of HEIs. This shift, according to

the authors of the reform, should modernise Lithuanian HEIs by making them more subordinate to both the needs of society and the market. Thus, the most important development of HEIs in Lithuania over the last few years was the shift in the concept of the HEI goals.

4.3 Monitoring and evaluation of the research performance

The research and higher education monitoring and analysis centre (MOSTA) is the principal state budgetary institution, whose function is monitoring, evaluation and formulating recommendations on the HE and research system in Lithuania. There are, however, external means to assess the research quality in the country. Firstly, the most important indicator is the ability to compete at international level in the field of research. The number of foreign PhD researchers in relation to the overall number of PhDs in the country, for instance, would indicate that Lithuania is one of the least internationally research competitive countries in the EU. According to the Innovation Union Scoreboard (IUS) 2011, in terms of the figure of non-EU doctoral students as a percentage of all doctoral students in the country, Lithuania with merely 3% was significantly below the EU-27 average (20% of all doctoral students). Nevertheless, the data indicates a sharp growth in the share of non-EU doctoral students as a percentage of all doctoral students in Lithuania over the last few years: according to the Innovation Union Scoreboard (IUS) 2010, in 2007 there were no non-EU doctoral students in Lithuania. The World University Ranking is another such instrument to measure the quality of research in Lithuanian institutions. Finally, there are studies, conducted by external experts from abroad, aimed at evaluating the overall situation of research in Lithuanian HEIs (for example, "Lithuanian Research Performance Overview" by Krzysztof Szymanski published in 2011[17]). In addition, the Centre for Quality Assessment in Higher Education (CQAHE), an independent public agency established in 1995, along with other study programmes also regularly evaluates and accredits PhD programmes in Lithuanian HEIs.
The Lithuanian Minister of Education and Science posed competitiveness-based funding of both research and studies as one of the principal goals of the HE reform. According to the new Methodology for allocating „block" funding for public research introduced by MoES, half of the allocated funds depend on the number of researchers employed, and half on the results achieved (bibliometric indicators and peer review based evaluation applied). As a result, the share of research funding on the basis of research quality and results in relation to the share of institutional „block" funding increased to 50% of all research funding in Lithuania (prior to 2009 it constituted 12%, and in 2009-2010 – 40% of the funding).

5. Facilitate partnerships and productive interactions between research institutions and the private sector

A poorly developed intellectual property legal base remains one of the principal obstacles precluding successful partnership and productive interactions between the business sector and research institutions in Lithuania. Moreover, almost none of the research institutions in the country has Knowledge Transfer Offices (KTOs) established and in these cases when it is actually established, the functioning of the KTOs is aggravated by the lack of interest from the PROs" administration and the lack of competent IP management specialists in the country.
The clearest recent Government initiative directed at fostering research-business cooperation is laid out in the Lithuanian Innovation Strategy 2010-2020, the sole strategic document, which explicitly declares an objective of public-private knowledge transfer and promotes researchers" inter-sectoral mobility. There are three key elements of this strategy:

1. "Support for the protection of the industrial property rights", which is administered by *the Agency of Science, innovations and technologies* (MITA) and has two principal objectives: (1) financial support for patenting of research products (buying of a European patent, or of a patent granted through Patent Cooperation agreement); (2) financial support for registration of designs (procurement of the Community's design, or of a design registered according to the Geneva act. In 2011, 14 industrial property rights projects were granted financial support amounting to €67,000.
2. Funding is provided to ensure inter-sectoral mobility for researchers, first of all the measure Employment of Researchers in Business (€9.1m) under the Human Resources Development OP that encourages employment of highly skilled researchers in private companies.

[17] Available at: http://www.lmba.lt/sites/default/files/Thomson_Reutors.pdf

3. A set of policy measures aimed at fostering the interactions between PROs and SMEs (the "integrated science valleys" initiative, development of clusters culture, joint research projects and other measures).

Another recent initiative aimed at promoting knowledge transfer from research to business is the Law on Research and Higher Education of 2009, which has guaranteed researchers with the copyright of their research products. In addition, knowledge transfer through the management of intellectual property is also facilitated by the Recommendations for Lithuanian Science and Higher Education Institutions on the Rights Emerging from the Results of Intellectual Activity approved by the Minister of Education and Science in 2009.

Finally, "Innovation Vouchers" is a notable instrument, introduced by the Ministry of Economy of the Republic of Lithuania in 2010, which aims to foster cooperation between SMEs and research or HEIs. According to the regulations of this measure, an innovation voucher is a small grant (worth €2,900 or €5,900), which enables an SME to buy R&D expertise or knowledge from a research or higher education institution.

Prior to 2009 business participation in the management of HEIs was slack. The legal foundations for more active business sector involvement in the governance of Universities were laid out with the HE Reform of 2009. The strengthening of the University Boards and the introduction of the rule, according to which half of the Board is comprised from members outside of the university, will most probably result in a model of university governance, where fiduciaries (social-partners) will have much more influence than in the previous system. This, in its turn, should empower private business in relation to university governance.

6. Enhance knowledge circulation across Europe and beyond

Currently Lithuania participates in five bilateral and trilateral international research programmes. These programmes totalled €0.56m allocated grants and included 68 administered projects (for more details see chapter 7 of the Annex). In addition, Lithuania has also signed mutual science and research cooperation agreements with many EU countries. It is also worth noting the measure PRO-LT, whose principal aim is to support transnational R&D collaboration activities. The beneficiaries of the measure are the Lithuanian Research Centre and higher education and research institutions. The total budget of the measure is €17.4m. Following the implementation of the measure, mutual agreement of cooperation between IBM and Lithuanian universities in the field of R&D was signed along with the establishment of Lithuanian Research Centre in 2011. In addition, the Promotion of Advanced International Scientific Research in Lithuania (€11.6m) that started in 2010 will support joint international R&D projects, developed together with foreign industry firms.

The most important Lithuanian initiative in supporting the development of a sustainable, efficient and effective European scientific information system is the Lithuanian virtual university 2007-2012 programme, which declares integration of the Lithuanian scientific information system into the European information infrastructures as one of its principal objectives. According to the programme strategy, the integration of the Lithuanian science and education system in the European information space is one of the preconditions for an increase of research and education quality in Lithuania. In order to achieve these goals in 2008 the Lithuanian Academic e-Library (eLABa) conducted a Development Opportunities Study, which elicited the strategy of creating an integrated and open source Lithuanian scientific information system, accessible to the rest of the European scientific community.

Open circulation of knowledge and open access to research outputs is supported indirectly through the measure Improvement of the Qualifications and Competencies of Scientists and Researchers (scientific databases, e-documents) (€21m). The measure aims at developing the skills and competences of Lithuanian research by creating access to international scientific information data-bases, by relevant training of researchers and librarians and by collection and dissemination of Lithuanian scientific publications through the international databases (the development of the international data base LITUANISTIKA, development of the archive of social sciences and humanities data, dissemination of the information infrastructure of the Lithuanian Science and Studies Computer Network LITNET).

Information on R&D activities results is also disseminated in society through the measure The Creation of National Open Source Scientific Communication Centre (2008 – 2013, €29m). The principal rationale of this measure is to make public the information on research groups and research activities, performed in more than 30 Lithuanian higher education and R&D establishments.

7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world

Although the Lithuanian Innovation Strategy 2010-2020 declares the objective of including Lithuanian researchers in the building of ERA, there is no evidence that Lithuania had a single, clear strategy to realise this goal. The current government agenda shows that policy emphasis is put on the internationalisation of the HE system rather than on research: The Programme for Internationalisation of Higher Education in Lithuania 2008-2010 has no measures to foster internationalisation of research.

In 2010 Lithuania was participating in five bilateral (or trilateral) international research programmes:

1. Lithuanian-Latvian-Taiwanese research programme (2000) with no specific priority fields of scientific research;
2. Bilateral Lithuania-Belorussia agreement (2008) prioritising these fields of research: new materials and new energy sources; medicine, pharmaceuticals, industrial biotechnology; Information and telecommunications technologies; agricultural production, processing and storage technologies; energy resources and sustainable competitive production technologies; ecology and rational utilisation of natural resources; Social Sciences and Humanities;
3. Lithuanian-French programme "Gilibert", with no particular scientific fields of research prioritised;
4. The Lithuanian-Ukrainian programme for cooperation, prioritising these areas of research: Information and new production technologies (laser, high-precision, mechatronic, robotechnics, plasma, etc.); energy and energy efficiency; Ecology and Rational environmental protection; health sciences, treatment of the most common disease and prevention technology; research and biotechnology, bioengineering and genetics; new materials; Social Sciences and Humanities.
5. The Lithuanian-Swiss programme "Research and Development" (2011) is a constituent part of the Lithuanian-Swiss cooperation programme, according to tripartite agreement No CH-3-SMM-01 concluded on 5 November 2011 between the Ministry of Education and Science of the Republic of Lithuania and the public organisation Central Project Management Agency and the Research Council of Lithuania. The budget of the programme – 9.7 million Swiss Franc (CHF). The programme will be implemented during the year 2011-2016. One (exceptionally – two) call for proposals will be launched. The programme is dedicated to implement joint research or institutional partnership projects in the field of environmental science and technology, health/life sciences, and natural sciences.

In total the above-mentioned programmes included 68 administered projects with about €0.56m allocated grants. In addition, Lithuania has signed 16 other bilateral agreements with ERA countries; but this, however, has not led to active governmental involvement with funding.

In terms of research collaborations with third countries, Lithuania has not developed any scientific research internationalisation strategy directed specifically at non-EU countries. Moreover, despite the existence of several bilateral and trilateral research cooperation agreements with programmes of the third countries mentioned above, most of these did not develop into active collaboration and co-funding of research. The poorly developed strategy of cooperation with third countries is also reflected by the fact that there are still no operating mobility schemes targeting researchers from these third countries.

Due to the absence of a single strategy for international research cooperation, there is no evidence that specific research fields or countries are prioritised for cross-border collaboration. The current trends of cooperation in the area of research, however, allow assuming that the policy of scientific research cooperation in Lithuania prioritises the same countries as the HE internationalisation policy, laid out in the Higher Education Internationalisation programme for 2011-2012: North European countries; neighbouring EU countries; third countries providing competitive higher education: Japan, USA, Australia; post-Soviet non-EU countries; rapidly developing Asian countries.

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List of Abbreviations

BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
CHF	Swiss Franc
CLARIN	Common Language Resources and Technology Infrastructure
COST	European Cooperation in Science and Technology
CPVA	Central Project Management Agency
CQAHE	Centre for Quality Assessment in Higher Education
ERA	European Research Area
EPO	European Patent Office
ERA-NET	European Research Area Network
ERDF	European Recovery Programme Fund
ESA	European Space Agency
ESFA	European Social Fund Agency
ESFRI	European Strategy Forum on Research Infrastructures
FP	European Framework Programme for Research and Technology Development
eLABa	Lithuanian Academic e-Library
ELI	Extreme Light Infrastructure
ESF	European Social Fund
EU	European Union
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	Framework Programme
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D

HES	Higher education sector
ICT	Information and Communication Technologies
IP	Intellectual Property
IPR	Intellectual Property Rights
IUS	Innovation Union Scoreboard
JHEP	Joint Programming Initiative on Cultural Heritage and Global Change
JRP	Joint research programme
KEF	Knowledge Economy Forum
KIS	Knowledge Intensive Service
KTO	Knowledge Transfer Offices
LBSA	Lithuanian Business Support Agency
LCQAHE	Lithuanian Centre for Quality Assessment in Higher Education
LIC	Lithuanian Innovation Centre
LIS	Lithuanian Innovation Strategy for 2010-2020
LITNET	Lithuanian Science and Studies Computer Network
LMA	Academy of Sciences
LRC	Lithuanian Research Council
MoE	Ministry of Economy
MoES	Ministry of Education and Science
MITA	Agency for Innovation, Technology and Science
MOSTA	Research and higher education monitoring and analysis centre
NCPs	National Complex Research Programmes
NIP	National integrated programme
NIS	National innovation system
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PCT	Patent Cooperation Treaty
PPMI	Public Policy and Management Institute
PPS	Purchasing Power Parity
PRO	Public Research Organisations
RCP	Researchers Career Programme
R&D	Research and development
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
SF	Structural Funds
SME	Small and Medium Sized Enterprise
SSF	State Studies Foundation
S&T	Science and technology
VC	Venture Capital
VST	State Studies Foundation
VU	Vilnius University
VULRC	Vilnius University Laser Centre

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Abstract
The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

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